Teacher's Manual for

THE SEASONS PASS

The
HOW
AND
WHY
ScienceBooks

Frasier

A TEACHER'S MANUAL
AND SCIENCE HANDBOOK
to accompany

THE SEASONS PASS

BOOK III

of the

HOW AND WHY SCIENCE SERIES

including also

A KEY TO THE COMPANION BOOK

Prepared by

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CONTENTS

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THE HOW AND WHY SCIENCE BOOKS

WE SEE (PRE-PRIMER)
SUNSHINE AND RAIN (PRIMER)
THROUGH THE YEAR (GRADE 1)
WINTER COMES AND GOES (GRADE 2)
THE SEASONS PASS (GRADE 3)
THE HOW AND WHY CLUB (GRADE 4)
HOW AND WHY EXPERIMENTS (GRADE 5)
HOW AND WHY DISCOVERIES (GRADE 6)
HOW AND WHY EXPLORATIONS (GRADE 7)
HOW AND WHY CONCLUSIONS (GRADE 8)

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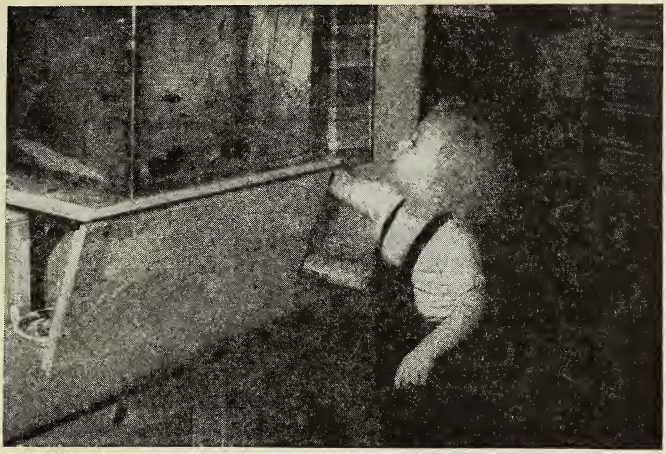


"All knowledge begins in wonder."

ELEMENTARY SCIENCE

THE PHILOSOPHY OF SCIENCE TEACHING

Someone has said, "All knowledge begins in wonder." A child entering school for the first time brings with him spontaneous enthusiasm and interest in the world about him which manifest themselves in an eagerness to relate his experiences. He is full of questions about the caterpillars, frogs, turtles, and other live things that he finds as he plays. He is curious about the weather, the heavenly bodies, and other physical phenomena of his environment. He asks how and why the mechanical devices of his everyday experiences work.

Too often this natural curiosity of the little child is lost instead of being developed during the first few years of school life, because teachers and parents feel their inadequacy to meet the situation. The knowledge required to answer all these questions is so great as to discourage the average adult. When children are curious, they have no respect for the lines of subject matter. One question may fall in the field of biology; the next in physics or chemistry. To

answer all questions completely might well require more knowledge than even a specialist would possess.

However, to teach science to children it is not necessary to be able to answer all their questions. The alert teacher with abundant enthusiasm and curiosity can help them find the answers to many of their own questions. Nowhere will her efforts bring more satisfying results than in the teaching of science.

The philosophy of science teaching differs very little from that of any other subject. It is the subject matter which makes the handling of it more difficult, because teachers are not generally trained for science teaching. The teacher must take into account those things in the child's experience which lie in the field of science. There are many experiences common to children everywhere that may become the foundations of our science work. From these common paths teachers may diverge with the interests of individuals and the groups, and adapt the teaching to the local community or section of the country.

We live in a world that is changing so rapidly that what is grist for the science mill today may become a waste product tomorrow. One day a Byrd explores Antarctica; a Beebe explores the depths of the ocean; or a Piccard penetrates the stratosphere. At such times even first-graders may discuss the stratosphere but to put the stratosphere into a first-grade book, in the light of our present knowledge, would be questionable.

Again, the children we teach are affected by varied environments. Those of the western plains have a whole set of animal concepts not possessed by children of the Atlantic coast. Children in a mining town, children from the country, children from a metropolis—all have experiences which give them different ideas. But through all these experiences the teachers may teach the same scientific principles. For example, hibernation of animals may be taught to a western child by a study of snakes; to a child in the lake region by a study of frogs; to a child somewhere else by the study of clams, crayfish, or some insect.

In science, the teacher needs to remember individual differences. Some children respond more freely to experiences with plants, some to animals, some to physical science. By encouraging children to express themselves freely in the classroom, and to experi-

ment for themselves with the materials found in the science room, the teacher can discover these differences and make effective uses of them.

Above all, to be a successful teacher of science, one must be enthusiastic about the subject, enjoy working with children, and understand the way they think. She must be scientific in her own attitudes and be able to use the problem-solving method of teaching. She does not have to be a specialist in science nor be afraid that she won't know all the answers. She probably won't be able to answer all the questions which the children ask, but even if she can, to do so would spoil the fun for the children. She need not hesitate to say, "I don't know," providing she continues, "but we'll find out together." Science teaching can be a shared experience of teacher and children that has great possibilities for both.

OBJECTIVES FOR TEACHING SCIENCE TO CHILDREN

Science for the grades should not be regarded as a mere accumulation of facts but as a series of experiences with the science materials that are a part of every child's daily life. These experiences stimulate the curiosity of children and if used properly should lead to behavior changes in the children. To accomplish desirable outcomes the teacher should understand the reasons why anyone studies science. These reasons may be called objectives. Scientists differ in the way they state these major objectives, but they agree on their content. Briefly stated, these objectives of elementary science are:

1. To develop an intelligent appreciation of the natural and physical world.
2. To develop scientific attitudes.
3. To help the child acquire the scientific method of problem solving.
4. To help the child acquire useful knowledge of scientific principles.

By an intelligent interest and appreciation of the world in which he lives, a child is made aware of real beauty that goes deeper than

the mere appeal to sense. Appreciation grows as knowledge is gained. The person who gets a satisfaction from the color and form of a beautiful butterfly should enjoy it more after seeing it go through its transformation from pupa to adult. The child who, looking intently at a butterfly's chrysalis, exclaimed, "Oh, I can see the wings through the chrysalis skin!" was experiencing appreciation. Children should get a thrill out of their science experiences which will make their lives richer and more enjoyable.

Appreciation should lead to the conservation of wild life. The biological principles of the struggle for existence and survival of the fittest make for a balance in nature, unless it is upset by man. Through experiences with material such as that used in "Insects in the Garden," "Birds in the Orchard," and "Life in the Pond," children may be led to see the relationships of plants and animals. They learn which ones are harmful, and what to do about them, as well as which ones are helpful to man.

The second objective, that concerning scientific attitudes, should run through all science teaching. The child who has these scientific attitudes:

(*a*) Will have a conviction of basic cause-and-effect relation which will make it impossible for him to believe in superstition or unexplained mysteries.
(*b*) Will have a sensitive curiosity which will lead to making accurate observations, collecting data, and searching for adequate explanations.
(*c*) Will have the habit of delayed response, preventing him from making snap judgments or jumping to conclusions.
(*d*) Will weigh evidence carefully to find out if it is sound, pertinent, and adequate.
(*e*) Will have respect for another's point of view, being willing to change his point of view in the face of new evidence.

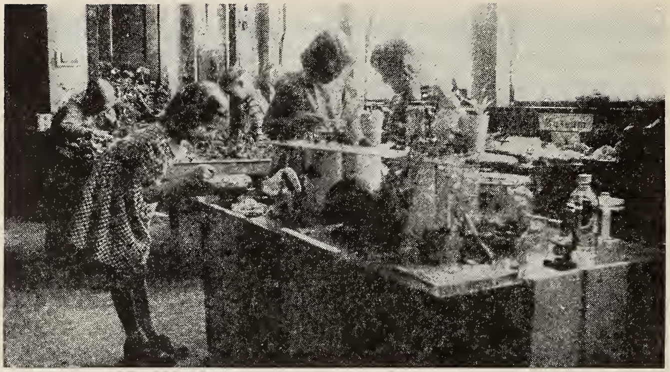
These may sound formidable to the teacher who has had little training in science. She may recognize them as desirable outcomes, yet not have the slightest idea of how to go about teaching them. She need not be frightened, however, because the techniques by which she helps children develop scientific attitudes are

very similar to those she uses to develop social attitudes. The first step is to be able to recognize a *lack* of the attitudes.

For example, a child who says, "My grandmother says the ground hog saw his shadow and he can tell about the weather," does not have the attitude of looking for a cause. The teacher could help him develop the attitude by saying, "That is interesting. I wonder what makes your grandmother think that," or, "I wonder what the ground hog (woodchuck) knows." The child may answer, "If he sees his shadow on ground-hog day, we'll have six weeks of bad weather." Then the teacher may say, "That may be true, but what do the rest of you think about it?" After a brief discussion she may say, "All of you are just giving ideas. Is that the way scientists (or people who study woodchucks) would settle a question?" The children may suggest watching for woodchucks or discussing the weather on February 2—will the woodchuck see his shadow or not? They may watch the weather for six weeks, recording it and comparing the actual weather with the woodchuck's "prediction." Some child may be bright enough to remark, "It may be cloudy in the fields south of town and the sun may be shining on the north side. The north side couldn't have six weeks of bad weather while the south side is having good weather." The grandmother (who would have resented it had the teacher said, "That idea is not true, Tom,") may become interested in a long-time experiment; but, whether or not there is hope for grandmother, Tom's plastic mind has been affected by six weeks of observing and checking.

Later when Dick insists that horsehairs turn into snakes, Tom will be eager to bring rain water and a horsehair to find out if Dick is right. Bit by bit, these experiences will straighten out Tom's thinking until one day he will say, "I don't believe in superstitions. One day when we were out driving, a black cat ran across the road. Later we had engine trouble, but the trouble was caused because a part had worn out."

Not only is this attitude taught by correcting existing superstitions and misconceptions, but it impels children to look for the causes of all natural phenomena. Numerous opportunities arise every day to develop it. For example, in trying to solve the problem of why food spoils, the teacher may ask, "Where does your



Independent investigations.

mother put food that she wants to keep?" Through discussion someone may say, "Temperature will affect food. When food gets hot, it spoils." In problem solving there are many opportunities to teach scientific attitudes.

The ability to interpret natural phenomena correctly does away with unreasoning fears. The child who understands the cause of thunder, and has demonstrated it in a small way by clapping his hands, is not so likely to be afraid of the noise. Knowing that animals are not likely to sting or bite except in self-defense, he is less susceptible to the fear carried by many people into adult life. The person who has studied about meteors and northern lights doesn't assign mysterious reasons or results to these natural phenomena. The child's understanding of the cause and prevention of disease helps keep him from carelessly exposing himself and others, as in the case of colds. He learns that everything has a cause; that disasters don't just happen, nor, as was once believed, are they visited upon us as punishment.

Curiosity concerning their environment is natural to children, though some have more of it than others. But sensitive curiosity may have to be taught. Children ask many questions to which they really don't expect an answer, nor care for one. Sensitive

curiosity is demonstrated by a perseverance on the part of the child in asking a question, or in independent investigation on his own initiative. Children should be given opportunities to tell of things they observe that stimulate their interest and curiosity. If learning is dependent upon desire to know, then curiosity is a valuable attitude to develop. Some children have it to such a degree that no amount of squelching on the part of adults will stop their investigations. They learn in spite of their teachers. Other timid ones stop asking when they get no satisfactory explanation. The child who persisted in saying, "I *want* to *know* what makes the bubbles in cake," after the teacher had told her it was too hard for her to understand, had unquenchable curiosity.

The ability to make careful, accurate observations and the ability to collect data are outcomes of the attitude of sensitive curiosity. Some teaching techniques which help in the teaching of this attitude are:

(*a*) Making use of the children's suggestions of ways to collect data—for example, when Mary wonders what will happen if a prism is held in a cloud of dust while a sunbeam is striking it, let Mary try it, using chalk dust.

(*b*) Insisting upon accurate descriptions when a child reports having seen something—for example, when a boy describing an insect the size of a gnat, tells of a yellow stripe around its body, the teacher may say, "Just a minute. How could you see the yellow stripe on an insect no larger than a gnat? Tell just what you saw. If you didn't see the color, don't tell about it."

(*c*) Setting an example of collecting data by asking questions about many points which the children have not mentioned in their descriptions.

(*d*) Insisting upon experimentation or demonstration being directed to the purpose of gaining adequate explanations. Children are likely to become more interested in the working of the apparatus than in the answer to their original question. Then the teacher may say, "Why are we doing this experiment? Is it helping to answer the question? It is an experiment only as long as you are learning. After that it is play."

The attitude of delayed response is developed by insisting on the children's not "jumping to conclusions." The child who says, "I saw a bird. I *think* it was a woodpecker because it was tapping on a tree," or "I *think* the fish died because we didn't put any green stuff in the aquarium like we do at home," or "I'm *not sure,* but I don't think the air does all of the work of holding the plane up," has developed the attitude. The child who says, "I *know* that was a fallen star. There are a lot of them around here," hasn't developed the attitude.

To help develop the attitude of delayed response, the teacher must be on the alert with answers such as:

"We must be careful and not think we have found out something when we really haven't."

"Do you think you should say they are fallen stars? Has anyone proved it?"

"Let's save that question and answer it later. Then we will find out more about it to help us be sure." (And don't forget to do it!)

Having developed the attitudes of basic cause and effect, sensitive curiosity, and delayed response, children are ready for weighing evidence. Children are usually eager to express their ideas without thought as to whether they are pertinent or sound. When the teacher is just starting her science program, she may encourage expression to get things under way. After the ice is broken and the children are no longer inhibited or shy, the teacher has to curb their enthusiasm and direct their thinking.

To do this without breaking their line of reasoning takes skill. The teacher must not be discouraged if her first attempts at developing attitudes result in confusion. She may have to go back to the beginning of the lesson and start over. When this happens, the teacher should take the children into her confidence by smiling and saying, "I guess I got us off on the wrong track. Let's see where we were," or "We're all mixed up. You'll have to help me. What were we trying to find out?" The children will respond to this.

Some ways to help develop this attitude of weighing evidence are to give suggestions like:

"Let's remember not to take too much time with details that don't really have anything to do with our problem."
"Does your question have anything to do with electricity? Have you thought it through?"
"Do you think that we have enough information to answer the question?"
"Should we decide before we know what a scientist has to say about that?"
"Let's keep our minds on one track."

By consulting an authority, the teacher should check often on the accuracy and soundness of the experiments being done. The children should check with their science text. They should never draw conclusions from one experiment.

A child who has developed this attitude will say things like this: "I think the tooth comes from the upper jaw by the way it curves. If you'll look at a dog's teeth, you'll notice that the upper teeth curve down over the lower teeth. It's hard to tell whether it's the upper tooth of a big bear or the lower tooth of a small bear," or "We haven't read it carefully enough. He forgot to use a marker so I don't think it would be right."

Willingness to change one's opinion in the face of new evidence is the most advanced attitude of all. The person who has it is tolerant, without prejudice and bigotry. If all the children in the world could really be taught this attitude so that it would function, wars would cease. Science has no monopoly on this attitude, but it offers an excellent opportunity for its natural development. In social studies areas, emotions are more likely to be involved. In solving science problems, children can be more objective. The teacher may say:

"There is a sentence on that page that isn't exactly scientific. Scientists have found out more about it since the book was published."
"When one has the floor, let's remember that others want to talk also, and not take too much time."
"Don't laugh. I'm not surprised that he's mixed up. Grown folks get mixed up, too."
"Do we laugh at people who have ideas?"

"Let John have his chance. Let's listen to what he has to say."
"I think he has an idea, but it just isn't very clear."
"Evidently there are three people who do not agree."
"Jane listened to you; now it is her turn."

Allow every child an opportunity to tell one thing he has observed or learned from an experiment. Give careful consideration to every child's serious question or attempt to explain something. If the teacher respects children as individuals, respects the importance of their problems, and is willing to change her own mind when she sees that she is wrong, it will help in teaching this attitude.

The child who has this attitude will say, "I don't quite agree with her because I think there is a change in the temperature of the land," or "I thought the candle wick burned, but now I know that it is the gas that burns."

Children often have pretty definite ideas about their experiences and are not willing to change those ideas. For example, many people use widely advertised products in their homes without investigating their true value. One science group made a study of some of these products and discovered that the advertising was misleading. The children in the group were learning to evaluate and test statements in the light of evidence.

Willingness to change opinion, to search for the whole truth, and to base judgment on fact are all closely related and may be developed together. They may all result from a comparison of experimental data or accurate observations.

A child may have formed some incorrect idea that he has heard or read in a book. For example, a child insisted that "beavers carry mud on their tails" because he had read it in a children's storybook. The other children challenged his statement. The teacher asked how they could know whether or not the statement was correct. The children said to ask a scientist or look it up in several books written by scientists who had studied beavers. When this was done, the child who had made the statement saw that his idea was wrong. He also realized that he could not believe everything he read.

TEACHING PROBLEM SOLVING TO CHILDREN

Many elementary teachers have themselves not had the advantage of science training and do not know how to teach by the problem-solving method. Although it is not unique to the field of science, the average elementary teacher may not have learned the techniques necessary to help children learn it and use it. Even if teachers have used problem solving in teaching social studies or arithmetic, unfamiliarity with the science fields may make them hesitate to apply it in that area. Yet science problems are such a natural part of every child's world that the questions he asks are the easiest approach to the development of these particular skills and habits. Since educators agree pretty uniformly that our major objectives lie in the areas of appreciations, attitudes, skills, and habits rather than in subject matter as such, the training of children in the problem-solving method seems very important.

The first thing that a teacher must do before starting to help children learn problem solving is to be able to recognize good problem situations and good problems. Among the questions that children ask are many that are of passing interest and may be answered quickly and easily. But often some of these questions offer opportunities for real problem solving.

For example, a group of first-graders, during their science meeting were reporting their observations of natural happenings. Some of the questions about an icicle that one child showed were:

1. Can you see through that ice?
2. Why is the ice frozen around the stick?
3. Would it freeze again if we put it out today? (The icicle was melting.)
4. How was the icicle made?

The teacher recognized number four as a good problem to help the children start developing some skills, so she used it. The other questions were used in developing the problem.

Some of the things to keep in mind when selecting a problem from children's questions are:

1. Is it suitable for the age level of the child who is trying to solve it?

2. Is it worth spending time on?
3. Are the materials available with which to solve it?
4. Does it offer opportunities for many child activities?
5. Are the children interested in it?
6. Can it be solved within the interest span of the group?
7. Does it contain the elements that make it a real problem to the children?

To illustrate these criteria let us test the problem, "How was that icicle made?"

With a group of children who had had no previous experiences with ice, the problem might have been too difficult. To know this a teacher needs to analyze the problem for the concepts necessary to its understanding. Some of these concepts in this case are:

1. Ice is frozen water.
2. Water freezes out of doors in winter.
3. Heat melts ice.
4. Sunlight gives heat.
5. Snow is frozen water.

The first grade which asked the question about the icicles had developed these concepts in the kindergarten, so this problem was suitable for their group. The problem might have been just as suitable for a fifth or sixth grade which had not had the science experiences of this first grade.

Testing the problem by the second criterion, "Is it worth spending the time on it?" one might say that it isn't very important to know how icicles are formed. Certainly many adults are leading happy, useful lives without the knowledge. We can't justify the value of the problem by the knowledge objective.

From the standpoint of appreciation, icicles are beautiful. That is one reason they attract children. Icicles are also interesting and arouse curiosity. Curiosity, if properly directed, leads to the scientific attitude of sensitive curiosity. Besides these values, the fact that the children are trying to find an answer to their own question makes it an ideal way to develop problem-solving skills.

The third criterion, "Are there materials available with which to solve it?" is satisfied, since in winter we have temperatures for simple experiments with freezing. The fourth criterion, "Does it

offer opportunities for child activities?" is met in that all of the experiments, demonstrations, and observations needed for solution are easily done by six-year-olds. It satisfies number five, "Are the children interested in it?" because the children initiated the problem.

Criterion number six, "Can it be solved within the interest span of the group?" is satisfied at whatever age level we are solving the problem. In the first grade which raised this problem the interest span was rather short. The group met with the science teacher only once a week for a twenty-minute period. Yet for two or three weeks the children kept bringing icicles of different sizes and shapes to the science room, commenting upon them in such a way as to demonstrate an understanding and an appreciation of their formation. Of course their understanding was not as complete as that an older group would have, but as far as it went it was correct.

To check with criterion number seven, "Does it contain the elements of a real problem?" we must analyze what we mean by the elements of a good problem. Why is "How was that icicle made?" a good problem while "Can you see through the ice?" isn't so good?

In the first place, a problem must present an obstacle in thinking. "Can you see through the ice?" presents very little difficulty because to answer it the child merely holds the ice up and tries to look through it. There is no need for the problem-solving technique. The other question cannot be answered so readily. Unless the children have already met the question before and had it answered, they must discuss it and give possible answers based on their previous experiences. Then they must test these possible answers in various ways, finally drawing conclusions from the results of their data. True, this will be done very simply in the first grade, but by repeated learning situations of this kind even six-year-olds begin to develop these skills and habits.

Elementary teachers often say, "It is all very well for a science teacher to talk about these methods of teaching science to children, but theory and practice are two different things. *We* have to teach the children." Elementary teachers are justified in this criticism. Too often college teachers have a tendency to deal with

ideas and theory, neglecting contact with practical teaching situations.

For that reason let us examine several actual problem-solving lessons as taught at different grade levels, for the teaching skills needed to teach them.

The first one was taught in a first grade, and used only the materials of the environment. The problem was child-initiated when there was a hard rain and the children found earthworms on the sidewalk.

PROBLEM: Why do earthworms come out of the ground when it rains?

ANALYSIS:

Teacher's questions—

1. Where do earthworms usually live?
2. What must live things have in order to live?
3. What ideas do you have about why you found the earthworms on the sidewalks?

Hypotheses or possible answers given by the children were—

1. Maybe the earthworms want water.
2. Maybe the earthworms come out to breathe.
3. Maybe there is too much water in the ground so the earthworms will drown if they don't come out.
4. Maybe the earthworms' homes are ruined by rain and they have to come out.

SOLUTION:

A. Gathering data:

The teacher asked the children to suggest ways of finding out whether or not their answers were correct. As a result of the discussion, the children did these activities.

1. They put some earthworms on top of some soil and watched them burrow into the ground.
2. They examined some soil with a hand lens to see the spaces between the soil particles.

3. They put soil in water and saw bubbles of air escaping.
4. They poured water into a glass jar of soil until all of the air had bubbled out of the soil and water was standing on the soil.
5. They found earthworms in puddles where they had been unable to find drier soil.
6. They put water into the jar containing the earthworms and watched the earthworms.
7. The teacher drew an enlarged diagram of an earthworm's burrow to illustrate the relative sizes of worms to soil particles and air spaces.

B. Results:

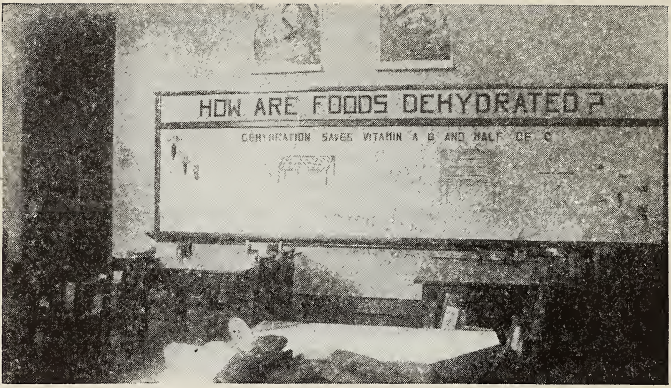
1. The earthworms burrowed into the moist soil, head end first.
2. The soil particles looked like tiny rocks.
3. & 4. Bubbles of air were plainly seen.
5. The earthworms in the puddles were dead.
6. As the water filled up the spaces between soil particles and air came out, the earthworms came to the surface and crawled out of the jar.

CONCLUSIONS:

When the earthworm's hole was full of water, it couldn't get air so it crawled out. When the ground was dry it would crawl back into its hole. If the earthworm couldn't get back into its hole and the ground was covered with water, it died.

This was a very simple problem but it offered all of the elements of real problem solving on a six-year-old level. The information could be gathered by the children themselves and was concrete enough for them to draw correct conclusions. They could check their results with those of the children in the story of earthworms in THROUGH THE YEAR.

This problem-solving lesson has illustrated the utilization by the teacher of a child's question for accomplishing her own objectives. We cannot always wait for questions to arise naturally to



As children grow older, their problems enlarge.

initiate science problems. The teacher must know the problems that are suitable for the group she is teaching, and at times she must create situations to motivate the setting up of these problems. Once initiated, the science program will usually keep going under its own power. New problems will grow out of those in the process of solution. The teacher and children will find themselves with more problems than they can possibly solve in the time they have. These problems should be recorded and used to start another year's work, or handled through individual or group reports.

As children grow older and develop more skill in handling problems, their problems will enlarge. They may break down these larger problems into minor problems to be solved. The time taken for solution will increase and the children may be taught to recognize the steps in their thinking. They may begin to record their data. This will be a group activity at first, with the teacher writing on the board the simple statements made by the children.

For example, a second grade in trying to answer their questions of "How did this piece of salt get on the shore of Salt Lake?" did some simple activities to clarify the concepts of *solution* and *evaporation.* At the end of one activity the teacher wrote the following results on the board as the children gave them to her.

1. Salt dissolves in water.

2. We couldn't see the salt in the water.
3. When the water evaporated we saw the salt again.

These children were able to check the results of this activity by reading in their second grade science text, WINTER COMES AND GOES.

Third-graders have developed enough reading skill to be able to supplement their own observations and experimentation by reading. They are also able to begin writing a few sentences as a record of the conclusions to their problems. The teacher should handle this just as she does the written language work the children do, being sure that the conclusions recorded are correct.

Analyzing problem solving for some of the difficulties that arise in teaching it, let us look at a rather simple lesson, "Why does a candle burn?" What are the concepts and skills a child needs for setting up the hypothesis and solving it? Some of the concepts needed are:

1. A candle is made of wax.
2. Wax is a solid.
3. Wax melts when heated.
4. Solids may be changed to liquids by heating.
5. Liquids may be changed to gases by further heating.
6. There is something in all fuels that burns.

Some of the skills the child will need are:

1. Ability to handle the simple apparatus needed.
2. Ability to observe accurately.
3. Ability to work carefully.
4. Ability to draw correct conclusions from accurately observed results.
5. Reading and language skills necessary for checking his results and recording them.

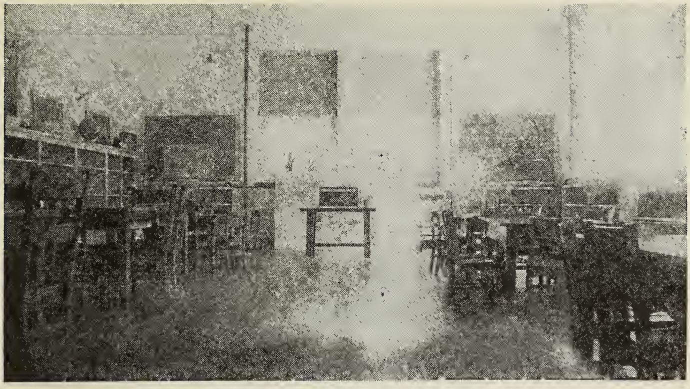
The teacher has to anticipate all of these needs and plan carefully. She must realize the safety measures to be provided in any experiment involving fire. She must guard against unscientific attitudes, such as drawing conclusions with insufficient evidence. She must be alert at every step in the procedure for opportunities to develop scientific attitudes and good habits of thinking.

Perhaps this all seems like a very complicated and difficult task to the teachers who have not used the problem-solving method. It would be if you started out trying to teach it all at once. If you begin slowly, one step at a time, you will find the children cooperating eagerly. The satisfaction gained by feeling that you are teaching habits of thinking that the children will be using long after they've forgotten some of the bits of information makes the effort worth while. A child's spontaneous comment at the end of the solution of the problem, "Why do teeth decay?" illustrates this point. It had taken some time to finish and the teacher was feeling a bit discouraged at the seeming waste of time. The child wrote his last sentence of the conclusion with an audible sigh of satisfaction and remarked, "Boy! I call that finishing a real job. That's really getting something when you find out yourself instead of just reading." When the children themselves realize the value of their learning, it must be worth while.

These values, in part, are:

1. The ability to recognize and formulate problems.
2. The ability to set up reasonable hypotheses.
3. The ability to gather data by means of suitable activities for testing the hypotheses.
4. The ability to record accurate results.
5. The ability to generalize from results, draw correct conclusions, and check with an authority.
6. The ability to apply the conclusions to similar problems.

In addition to these skills and habits, scientific attitudes and knowledge are gained in the solution of pertinent problems.



A science room.

SCIENCE ACTIVITIES COMMON TO ALL GRADES

THE SCIENCE ROOM

The problem of how to care for materials and specimens is a real one for the grade teacher. If there is a separate science room, these may be cared for in the cabinets, display cases, and closets provided for them. If not, some space must be allotted in the regular classroom. They need not take up much room, for the apparatus needed for teaching elementary science is simple. A few glass jars, dishes and bottles, a few tin cans, some pieces of wire netting, cheesecloth and some candles may be the only things needed. An electric plate, alcohol lamp, or some other source of heat is necessary for some of the experiments suggested. But if these are not available, other common experiences may be substituted. In some schools it is against the rules to have fire in the classroom. Unless an electric plate can be obtained, the radiator is the only source of heat. There is such a variety of home-made equipment and substitutes for expensive apparatus that the ingenious teacher can always find some material for her activities. Running water is a great convenience. The children should have

Shelves provide places for permanent collections.

a share in assembling needed apparatus but the teacher must be responsible for seeing that it is ready when it is needed.

The regular classroom may be made more attractive with a few well-kept aquaria, terraria, and growing plants. Suggestions for maintaining these in good condition are given in other parts of this Manual. A science table will provide for the specimens of rocks, insects, birds' nests, and other things the children collect and bring to school. It should be well kept and cleared at intervals. As a child brings in his contribution it can be discussed, named, and put on the table with a small sign telling what it is and the name of the donor. A few cases of shelves will provide a place for more permanent collections.

A table with a few interesting things that the teacher provides helps to stimulate science work. These specimens should have labels telling enough about them to arouse curiosity and a desire to know more. For example, an oyster shell may be labeled, "This is the outside of an animal. It lived in the sea. It is used for food. You have a relative of this *oyster* in your aquarium. Do you know what it is?" The relative is a snail or perhaps a clam.

In some schools, glass display cases in the hall offer a place where science material may be exhibited. These exhibits should be changed frequently. For example, a group of children may

be studying rocks. They may put some of their best specimens, with neat labels, in the hall case. Other children of the school will enjoy this display and learn from it.

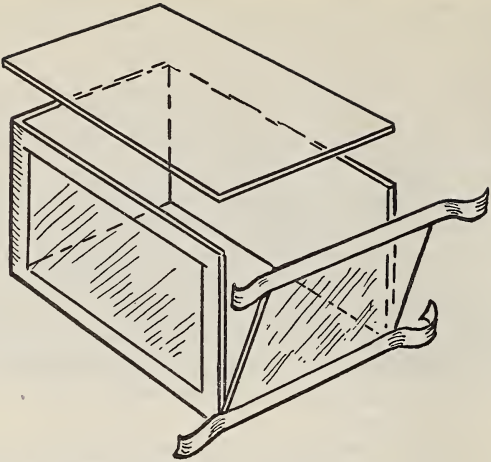
If the teacher wishes to buy equipment she may order it from any one of several scientific supply companies. Many of the things she needs such as dry cells, wire, and magnets may be bought at local ten-cent stores.

Bulletin boards are an important addition to the science room. They may be used by the children for the clippings and pictures they bring to class. The teacher may use them to motivate units or lessons, or to display summarizing activities at the end of a unit. They may be used for pictures of birds, wild flowers, or other aids to identification. There are many charts, such as the Audubon Bird Charts, which may be used for the same purpose. Bookshelves for reference books and magazines and a case for maps and charts should be provided.

Science material, whether it is alive, or is physical apparatus, must be kept in good condition. Nothing is so likely to kill the interest in science as dirty glassware standing around the room, cloudy aquariums, boxes of dead caterpillars, or unhealthy animals. There is much plain housekeeping in the science room, but all of it can be used to help teach children careful habits, particularly if the children are given the responsibility of helping to do this housekeeping.

HOW TO MAKE A TERRARIUM

A simple terrarium has so many uses that it is well to know how to make one. First, it is necessary to have a container. A glass jar of any kind will do, but one with straight sides is better than a round one. A glass box may be easily made from six pieces of window glass cut to the desired size. These may be fastened together with one-inch adhesive tape or black *passe partout* tape. Rub the tape until it sticks firmly to the glass. The lid may be fastened so that it is hinged, or merely laid across the top. All edges should be bound with tape to prevent cut fingers. A further precaution is to have the edges of the glass beveled at the time it is being cut.



A terrarium made from glass and adhesive tape.

A wooden base instead of a glass one may be used for the box. If wood is used, it should be so cut that at least one inch will project from around the glass at the bottom. The board may be treated with melted paraffin to make it resistant to water. A half-inch furrow should be sawed in the wooden base, the dimensions of the glass, and made wide enough to take the glass. The glass sides can be more firmly secured in the furrow by means of aquarium cement or putty. Adhesive tape may be put around the top to make smooth edges.

Having a container, start making the terrarium by putting a layer of gravel in the bottom, to provide drainage. Small pieces of charcoal will help keep it sweet. On top of the gravel put soil of the kind found where the plants grow which are to be used in the terrarium. For example, moss and ferns come from the woods. Use woods soil, or leaf mold, for a woods terrarium. Use garden loam for a garden terrarium. Use sand for a desert terrarium.

In the soil plant the moss, ferns, or other plants you wish to use. If you are going to put animals which eat plants into the terrarium, some of these food plants should be planted. For example, if

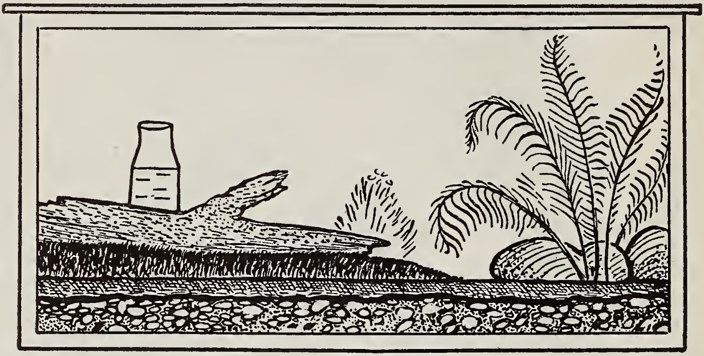
Making a terrarium for a garter snake.

making a home for grasshoppers, plant corn or oats and let it sprout before putting in the insects. For toads, use garden soil, a dish of water sunk into it, with perhaps some stones and a little grass. The toad will bury itself in the soil. Salamanders like moist moss and pieces of decaying wood under which to bury themselves. Lizards and horned toads will bury themselves in the sand of a desert terrarium.

The terrarium should be kept out of strong sunlight and in a place that is not too warm. It should be sprinkled with water when first made, if it has plants in it. After that it should be sprinkled only when the cover gets dry on the underside. Water should be kept in a dish if there are animals in the terrarium. Snakes go into water, and a tall container like a pint milk bottle or pickle jar of water will make them comfortable. A low dish is better for turtles and toads. This can be placed in one end of the

terrarium and stones and soil built up around it to the level of the top of the dish.

A single terrarium should not contain a large variety of animals. Since boxes of glass and adhesive tape are practical and inexpensive, it is better to have several, each one containing a different kind of animal.



A woods terrarium.

The food of frogs and toads in the wild state consists of insects, worms, caterpillars, snails, and slugs. They also eat flies, mosquitoes, and gnats. These can be easily provided, but they should always be alive. Frogs and toads will not touch dead worms or insects. They will starve in a terrarium if they have no live food to eat. A fly trap can be made and once a day the flies released from the trap into the terrarium. When there are insects out of doors, they may be caught by sweeping the grass with an insect net. In winter when flies are scarce, meal worms and meal bugs, which can be cultivated in bran flour, can be substituted.

Newts and salamanders can be fed on bits of raw meat, fish, oysters, scrambled eggs, worms, or insects. Land turtles are plant-eaters, using tender plants and berries for food. Water turtles are meat-eaters, using earthworms, insects, crayfish, and small fish. Mud turtles do not eat unless they are under water. Horned toads eat living insects. Garter snakes eat earthworms, insects, frogs,

salamanders, and toads. Snails are vegetarians; lettuce is a good food for them.

Care should be taken that an excess of uneaten food does not remain in a terrarium. Terrariums should be kept clean so that the captive animals may live in healthful conditions.

HOW TO MAKE AN AQUARIUM

Almost any container that holds water may be used for an aquarium, but a straight-sided one is best. The globe-shaped ones afford too little water surface for the absorption of air and they distort the shape of objects inside the aquarium.

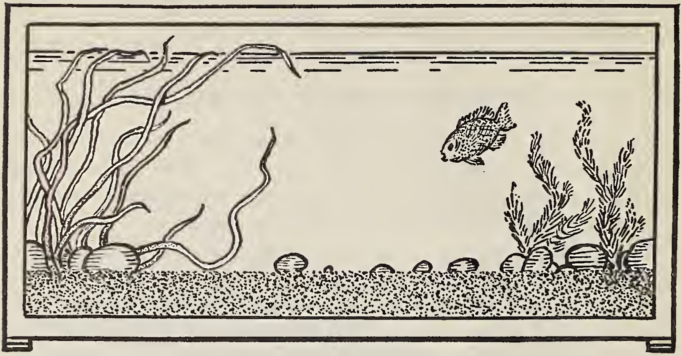
The container must be very clean, and the sand must be thoroughly washed. Sand may be washed by running a stream of water into the pan of sand until the water runs out clean. If the sand is then baked in an oven, any bacteria or mold spores will be killed.

Enough sand should be put into the bottom of the aquarium to insure a good root-hold for the plants. Elodea, eelgrass, and water milfoil are all good aquarium plants and are common in most of our fresh-water lakes and streams. These are satisfactory for summer aquariums but they do not always survive the winter. There are many inexpensive tropical water plants which can be used. Such varieties as Valisneria, Cobomba, Myophilum, and Sagittarium are commonly obtainable. It is believed that Valisneria is the best oxygenating plant. This is a grasslike plant which grows very quickly. Duckweed is a small leaflife plant that is often found floating on ponds. It is attractive in an aquarium, though it doesn't help to supply much oxygen.

The plants should be planted in the sand, then anchored with stones. Water can be poured into the aquarium without disturbing the plants by putting a piece of paper on the sand and pouring the water on the paper, or a dish may be placed on the sand into which the water can be poured.

Clean pond, lake, or rain water is best for an aquarium because it contains minute organisms that may later feed the animals. If tap water must be used, allow it to stand several days before putting it into the aquarium. This allows any lime that might spoil

the sides of the aquarium to be deposited and frees the water from any chlorine that has been added for purification. After adding the water, allow the plants time to become rooted before putting



A simple aquarium.

in the fish or tadpoles. Otherwise the animals may pull up the plants.

One rule for the number of fish in an aquarium is one three-inch fish to a gallon of water. Another rule is an inch of fish for each 20 square inches of water surface at the top. Most people are inclined to put more fish into an aquarium than the amount of water justifies.

Any kind of aquarium fish such as goldfish or tropical fish may be put into an aquarium. However, tropical fish are more difficult to keep than goldfish, and require more attention. The water temperature must be kept above 65° for tropicals, and the feeding must be more regular.

Of the tropical fish, guppies, swordtails, and paradise fish survive well and they have interesting habits. Guppies and swordtails are livebearers. Under favorable conditions, guppies reproduce every six weeks. The bubble-nests of the paradise fish are interesting. Tropical fish and goldfish should not be put together in an aquarium as tropical fish often kill the goldfish. Also the fighting paradise fish must be kept away from other tropical fish.

Some wild fish will survive in an aquarium and they make in-

teresting pets. Small sunfish, bluegills, and bullheads are examples.

Snails should be put into the aquarium to act as scavengers. They help keep the sides of the aquarium clean. Tadpoles will serve the same purpose. Clams also help keep the water clean. If water turtles and small frogs are put into an aquarium, they should be provided with flat pieces of wood onto which they can crawl and get out of the water for air.

The first rule in the feeding of fish is not to overfeed. Only a small amount of food should be given, or as much as will be consumed at that feeding. Food not eaten at once falls to the bottom of the container, sours, and makes the water impure. Goldfish can be fed as seldom as once a week. They should not be fed more than three times a week. Tropical fish should be fed three times weekly.

Oatmeal (cooked), boiled white of egg, cream of wheat (cooked), liver (cooked), beef (cooked or raw), chopped earthworms, and flies are good food for both goldfish and tropicals. These foods are better than artificial food. If wild fish are used, the children should find out about the natural food of these fish and supply it as nearly as possible. Wild fish can usually be fed on earthworms and chopped raw beef. They will also eat live insects placed on the surface of the water.

If the aquarium is balanced, the animals and plants will look healthy and the water will be clear. Cloudy or milky water is probably due to the spoiling of uneaten food, or to decaying plants. This water is bad for fish. Immediately remove the fish and clean the aquarium and replenish with fresh water. In changing fish from one container to another, keep water temperatures the same. Fish cannot stand sudden changes of temperature. Be sure also that tap water has been properly conditioned to remove chlorine.

Fish should be handled with a small net or lifted out in a dish of water. Grasping them with the hands is likely to break the film over the scales and permit fungus to get started. If a fish is diseased, remove it at once and put it into a solution of salt water, in proportions of one teaspoon of salt to a quart of water. It may remain in the solution for a period of several hours. Then put it

into a container of fresh water. Repeat the treatment every day until the fish is well.

The children will get much pleasure and profit from their management of both terraria and aquaria. There are many interesting aquarium books and magazines on the market to which they can turn for lists of animals and plants and for notes on feeding. Also in recent years there has been much interest in amateur tropical fish raising and many of the children may come from homes where there is a tropical fish enthusiast.

HOW TO CARE FOR CATERPILLARS

Some caterpillars spin cocoons, some form chrysalids, some go into the ground to pupate, some spend the winter hibernating in the larval stage. In discussing them with the children, suggest that since the caterpillars they find may not be ready to pupate, they must be sure to bring in some of the leaves on which they find the larvae. Then you will know what to feed them. Caterpillars will leave food and hunt a suitable place when they are ready to pupate. Polyphemus caterpillars may be put into a glass jar that has some twigs with leaves on them. A piece of glass may be laid over the top of the jar. This prevents escape of the caterpillar and also helps keep the leaves fresh. If the caterpillar is still hungry it will eat the leaves. The jar should be cleaned each day and fresh leaves put into it. When the caterpillar is ready to spin, it will use the twigs and sides of the jar as its foundation and spin leaves into its cocoon. When the cocoon is finished, it may be removed from the jar and put into a cool place until spring. Jar and all may be put away. If it is kept in a dry place, the cocoon should be dipped in water once in a while.

Caterpillars like the tomato sphinx (tomato worm) go into the ground to pupate. There should be some garden soil in the bottom of the jar for them. A flower pot with a cylinder of wire screening over it is good, also. Some Woolly Bears hibernate in the larval stage so a terrarium with some dead leaves and pieces of bark makes a good home for them. They will spin in the spring. Some Woolly Bears spin in the autumn.

The Monarch or milkweed caterpillar forms a chrysalis. If the children bring any Monarch caterpillars in, put them into a jar

with milkweed leaves. When ready to pupate, they will spin pads of silk on the underside of a jar lid, leaf, or twig, then hang from it and shed the larva skin, leaving the green chrysalis. Since the caterpillars that form chrysalids in the autumn soon emerge, they may be left in the room for the children to watch. Chrysalids of butterflies that emerge in the spring may be cared for in the same way as the cocoons.

Fruit and salad dressing jars are just as good as more elaborate equipment. The main things to keep in mind are to have fresh leaves of the right kind which are kept from drying too quickly but are not wet, and not to have too much heat. After pupae are formed, they should be placed in a cool place, not moist enough to mold, but not dry enough to kill the pupae. Cleanliness in their care is important, as many caterpillars are susceptible to disease. Also when handling caterpillars, be careful not to bruise them. It is better to let them crawl onto a twig and then move the twig, than to pick them up with your hands.

OTHER ANIMALS IN THE SCIENCE ROOM

The extent to which it may be desirable to keep animals in a schoolroom depends upon the size and facilities of the room, the interests of the children, and the kinds of animals you wish to keep. While some plants and animals if properly cared for are sure to make a room more interesting, we mustn't lost sight of the fact that the children are the most important occupants of the room. If having other animals makes the room less attractive or comfortable for the children, you should either do without the other animals, or choose animals that are easily kept in captivity and cared for.

Directions for the care of aquarium and terrarium animals have already been given. All these cold-blooded animals are clean in their habits and have little or no odor about them.

Small mammals such as rats, mice, guinea pigs, and rabbits may be kept in cages in the room if the cages are kept clean. Cages with removable metal bottoms are more easily cleaned than wooden ones. A cage may be made of an orange crate with a galvanized iron tray made to slide in the bottom of the box. One-

Observing a turtle.

half-inch mesh galvanized wire should be fastened to the open side and a sheltered corner should be made of a smaller box which is placed inside the cage. All animals need to have a place in which to hide.

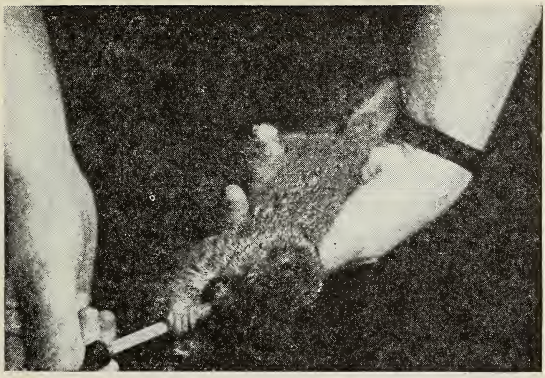
Sawdust or straw should cover the floor of the cage and be replaced with fresh material every day. If a layer of newspaper is put on the floor first, the cage can be more easily cleaned. The animal will carry some of the nesting material into its sheltered corner for a bed.

Guinea pigs and white rats are more easily kept in a schoolroom than rabbits. Rabbits may be brought in for a day or two, but it is better for them to live out of doors.

These rodents may be fed oats, alfalfa hay, carrots, and other vegetables. The young ones should have milk and a few drops of cod liver oil each day during the time when they do not get plenty of sunshine.

If the schoolroom is closed and becomes either very hot or cold over the week-ends, the animals should be taken to the home of one of the children. Extremes of temperature are not good for warm-blooded animals, particularly when in captivity where they can't protect themselves.

Although many of these animals are able to get their water from



Feeding a young squirrel.

their food, water should always be provided in the cages. The container should be low enough for the animal to drink from and of a kind not easily tipped over.

Wild rodents, such as meadow mice, squirrels, and chipmunks are sometimes brought into the schoolroom. Adult wild animals are difficult to tame and often refuse to eat. Young wild rodents, however, may be cared for and make interesting pets. If they are very young they may be fed on warm, diluted condensed milk. The smaller the animal the more warm water should be added to the milk, the more frequently it should be fed, and the less it should have at each feeding. One needs to use common sense in caring for these young animals. Keep them warm, let them alone as much as possible, and don't overfeed them.

Children sometimes bring other young mammals to school. Until the animal is old enough to eat solid food, its care is the same as for the other animals mentioned above. Teachers may find detailed directions for rearing all kinds of wild animals in Moore's *Wild Pets.* See reference list.

Young birds are easily reared if you know the food to give them. Any good bird book will tell the food of the common species of birds. Insect-eating birds may be fed earthworms, caterpillars, and small larvae of beetles. Hard-boiled eggs may be substituted

for part of their food. The shells should be crushed and fed with the egg. Young flickers may be fed on raw eggs and ants.

Seed-eating birds may be fed any kind of small seeds. Chick-feed is easily obtained. Some bread may be given them but should be supplemented with seeds. All birds need sand and other hard foods.

When a bird is first found it may have to be fed forcibly. Open its beak gently and put the food in the back of its throat. A pair of forceps or tweezers is useful in accomplishing this. The bird won't swallow unless the food touches the swallowing center on the back of its tongue.

Fish-eating birds such as bitterns and loons are occasionally found and brought to school. These are problems to feed as they do not thrive on dead fish. The author has successfully fed young fish-eating birds on live tadpoles and minnows.

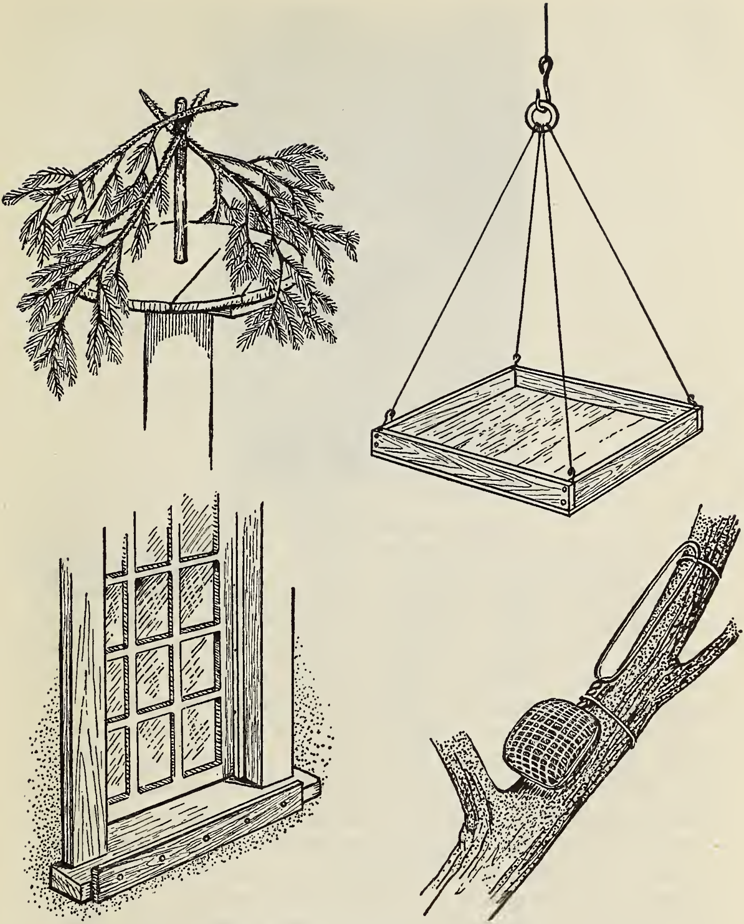
Hawks and owls may be fed pieces of meat which have been wrapped in cotton or rolled in sand. These birds should be handled with care as their bite is painful. Young ones soon learn where their food is coming from and open their mouths.

Unless a wild animal is too young to care for itself, it is wise to keep it awhile for study and then release it. School buildings are not built to house the lower animals. A trip to a well-run zoo will demonstrate how varied are the needs of the different groups of animals. It would be impossible to duplicate these conditions in a room where children live. A cage built outside a window on a level with the window sill will partially solve the problem. If a squirrel or rabbit is to be kept for any length of time this might be worth while.

In caring for any animal, the children should be made to feel responsible. They should read about the natural habitat and food of the animal and try as nearly as possible to duplicate these conditions. Even though some animals die, the value to the children makes caring for them worth while.

WINTER BIRD FEEDING

In the northern part of the United States most of the common birds migrate in the autumn but there are a few that remain through the winter. Why birds migrate is a question no one has



Simple feeding stations for birds.

solved satisfactorily, although there has been much written on the subject. The teacher should familiarize herself with the theories of migration and not try to solve the problem.

Half a coconut may be filled with melted fat.

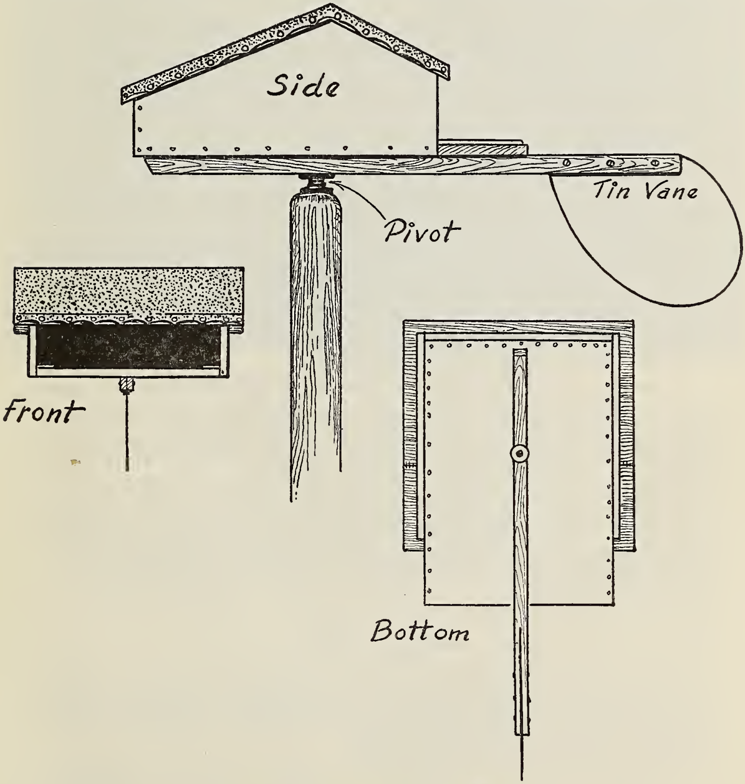
Some winter bird residents stay the year around in the north. Among these are the chickadees, nuthatches, and downy woodpeckers. Others come from farther north, spend the winter, and return to their northern nesting grounds in the spring. Brown creepers, juncoes, and tree sparrows are examples of these.

Some winter birds are insect-eaters and some feed on seeds or fruit. The downy woodpecker is able to chisel through the bark of a tree and with its tongue spear the larvae underneath. Nuthatches and brown creepers get insect eggs and insects from the crevices in the bark. Chickadees and titmice find their insect food mostly in the buds and on the twigs of shrubs or trees. But in winter, all of these will eat whatever they can find. Since they are meat-eaters, we put suet or nuts on the feeding shelf for them. To prevent suet from being carried away by a blue jay or starling, it may be put into a wire basket made of coarse screening.

A soap shaker may be filled with suet and hung from a wire. The suet may be tacked to a tree or tied to a limb. The nuts

should be crushed or finely cracked to prevent squirrels from carrying them away. Birds will scratch among the shells and pick up the bits of nut meats. Walnuts or hickory nuts are good bird food, and may be gathered by the children in the autumn, to save for winter feeding. Half a coconut may be filled with melted fat and hung from a branch. Cracked nuts or seeds may be added to the fat.

Juncoes, sparrows, goldfinches, and cardinals are seed-eaters.



A more elaborate feeding station.

Any seeds, such as wheat, oats, millet, or cracked corn, will attract them. Sweepings from a mill are welcomed by birds and they will scratch in the chaff for days, finding tidbits. Cardinals and grosbeaks are especially fond of sunflower seeds. Crumbs of any kind will attract birds, as will berries and pieces of other fruits. The children can put out discarded apple cores and cranberries. Breakfast food or other cereals which might be discarded because of weevils are good bird food. Even weed seeds are attractive to birds.

Shrubs with berries on them always attract birds. Among these are snowberry, barberry, high-bush cranberry, wild plum or cherry, and bush honeysuckle. Teachers who have anything to do with landscaping the school grounds should see that some such shrubs are planted.

A simple shelf is as effective as a more elaborate one. Just an extension from the window will work, although a roof prevents snow from covering the food. The birds may not come at first, so a good way to get them started is to sprinkle some grain on the ground under the shelf. The sparrows will come first and though we do not care so much for them, they show the other birds the way. A dry doughnut dangling at the end of a string will provide entertainment equal to circus acrobats.

A swinging shelf usually frightens sparrows and drives them away. However, for teaching purposes in the primary grades even an English sparrow has possibilities. It is surprising how many adults do not really know English sparrows.

In snowy, freezing weather, water is as hard for birds to get as is food, so water should be put out for them each day. It will often attract birds not attracted by food. A shallow earthenware container like the saucer of a flower pot is good for this purpose.

FIELD TRIPS

If properly conducted, a field trip may be an important activity to help in the solving of some science problem. Improperly conducted, it may be a waste of time.

A field trip must have purpose. It must come as a result of a need to learn something outside the schoolroom. It need not mean

A field trip—looking for birds' nests.

a long trip. For example, in a discussion of soil formation the question may arise of whether freezing and thawing break up rock and form soil. To illustrate this, the children may go outdoors and find rocks that have been cracked in this way. Even sidewalks and the foundations of buildings illustrate the point.

The teacher should anticipate any trip she plans and make the trip herself before she takes the children. If she intends taking the children to see birds, she should make sure that there will be birds to see. Birds are elusive and cannot be tagged and made to stay in one place. But a nest that is being built, or the work of a woodpecker located by the teacher or some member of the class, will remain until the whole class sees it. With a definite objective in mind, the teacher is sure to prevent disappointment and aimless looking.

Before starting on a trip, the teacher must be sure that every

A field trip—locating territories of birds.

child knows what he is going to look for. There is endless variety in the number of interesting things to see out of doors, but unless the attention is directed to a few, there will be confusion, and no learning will result.

For example, on the way to a river to see erosion, the group may watch for terraces that have been made as the river cut down to its present bed.

A large group should be organized into small units with a leader for each. These may be working on the same problem or different problems. If unusual things are found, the whole group may be called together to see them.

A simple way to organize groups is to make enough slips of paper for each member of the class. Number them from one to five. Circle one one, one two, one three, one four, and one five.

After a field trip—rock study.

Have the children draw slips. All the ones make a group. All the twos make a group, and so on. The children with the circled numbers are the leaders for the day.

Children like to make their own rules for field trips and take pride in following them. Here is a set of rules made by a third-grade class before going on a trip to study birds.

1. Walk quietly. No loud talking.
2. Follow your leader.
3. When you see a bird, stop. When the leader stops, everyone stops.
4. When you see a bird and want to show it to the rest of the group, tell them where it is without pointing. (Birds see better than they hear and are startled by quick motions.)
5. When you are looking at a bird, stand with your back to the sun.

Too many rules are confusing just as too many directions are. It is better to take short trips at first, trying out one rule; then add more rules as longer trips are taken. If the children understand what the trips are for, they will gain the proper attitudes toward them.

It is very important in any science work to respect the discoveries and ideas of children. When they see or find things on a trip, the group should give as serious attention to them as to the teacher's contributions. This encourages children to observe and it intensifies their interest.

On a collecting trip, enough containers should be taken along to carry back any specimens. Directions on how to collect and what to collect should be clearly understood before leaving the school. Collecting should be done only when material collected is to be used. If such material may be studied to better advantage in the schoolroom than out of doors, it serves a purpose. But only as much as is needed should be taken. Gathering hundreds of frogs' eggs would be wasteful when a few would be all the children could care for. It is better to raise a few tadpoles to adulthood than to have dozens die for lack of room or food.

Some of the types of trips may be listed as follows:

1. A trip to locate territories of birds. Return at regular intervals to watch nest building and rearing of young.
2. A trip to collect rocks.
3. A trip to see types of erosion.
4. A trip to find tracks of animals.
5. A trip to find and collect galls.
6. A trip to a zoo or museum to see something that has been discussed in class, such as fossils.
7. A trip to a meadow to collect weed seeds.
8. A trip to observe the sky.

The suggestions for teachers in connection with the stories list other ways to give purpose and variety to field trips. Trips should never grow so common or become so regular as to be monotonous, nor so dull as to be meaningless. Children should always regard them with enthusiasm, not because they offer an opportunity for play, but because they are the most satisfying solution to many of their science problems.

THE HOW AND WHY SCIENCE BOOKS

BASIS FOR CHOICE OF MATERIAL

CHILDREN'S INTERESTS

Children's interests were closely studied in preparing and organizing the material used in THE HOW AND WHY SCIENCE BOOKS. The subject matter was used by the authors in actual teaching experiences over a period of several years and with many different age groups of children. The problems were used in mimeographed form until arranged for publication.

RECENT COURSES OF STUDY

The material for the books was originally chosen from units that appeared in many courses of study from many sections of the United States. City and state courses of study were consulted, as well as those prepared and used in teacher-training institutions. More recent studies, problems which have arisen in the classes of the authors, and new courses of study have added new material to the original series.

The outlines for science in the elementary grades found in the *Thirty-First Yearbook* and in the *Forty-Sixth Yearbook* of the National Society for the Study of Education have been closely followed. Some quotations from the *Forty-Sixth Yearbook* are of interest here:

"Instruction in science should begin as early as children enter school; activities involving science should be provided even in the pre-school and the kindergarten. Through the sixth grade the work in elementary science should consist of a continuous integrated program of the sort advocated by the *Thirty-First Yearbook.* Such a program should provide an expanding, spiral development of understandings, attitudes, and skills, as prescribed in chapter iii."—pp. 41–42

"It is most important that the material selected for each grade of the primary school be balanced to include the elements of learning which represent a rich experience with science. Each level should give the child some opportunity for exploration with content derived from the great major fields of science: astronomy, biology, geology, and physics. This cannot be accomplished by studying only plants and animals.

"There should also be balanced instruction as to the types of activities employed. Children should have a rich opportunity to develop their abilities in discussion, in experimentation, in observing in the out of doors, and in reading for information and motivation. A complete program of instruction in primary science can be maintained only by the full utilization of all these activities, for each plays its part in the development of the purposes of science education."—p. 84

"Since experimentation involves 'learning by doing,' there can be no substitute for it. Pupil experimentation is an essential part of science education. In every course of science offered at any level, therefore, opportunities should be provided for pupils to perform experiments." —p. 53

"The basic purpose of the elementary school is the development of desirable social behavior. Science, with its dynamic aspects, its insistence upon critical-mindedness and better understanding of the world, and its demand for intelligent planning, has a large contribution to make to the content and method of elementary education.

"To accomplish this basic purpose a continuous program of science instruction should be developed throughout public school education, based upon a recognition of the large ideas and basic principles of science and the elements of the scientific method. Children must be given opportunity to gain the knowledge necessary for intelligent and

cooperative experience with the world of matter, energy, and living things and to develop constructive appreciations, attitudes, and interests. This demands that the individuals in our society become intelligent with reference to the place of science in individual and social life.

"When the content and method of science are examined, it is found that the child's normal activities have much in common with the purposes of science in modern society and that the teacher can view the teaching of science as utilizing the natural dynamic drives and potentialities of children."—p. 73

"Work in the primary grades should not be exhaustive. Rather the child should feel that there is more to learn about everything that he does. A developmental point of view demands that a well-balanced program provide contacts with realities. It cannot allow omissions in the development of the concepts, principles, attitudes, appreciations, and interests derived from the field of science."—p. 82

"The new program of science, which emphasizes the development of desirable social behavior, is organized around problems that have social value and are challenging and worth while to children. The teacher must, therefore, look back of the objects of the universe to the problems which involve meanings that the children will need to understand in order to participate intelligently in life. This means that, in science, opportunities must be provided for the development of understandings in all the areas of the environment and at all levels of social needs."—p. 92

HEALTH, SAFETY, CONSERVATION, AND AERONAUTICS AS INTEGRAL PARTS OF A SCIENCE PROGRAM

The authors of The How and Why Science Series have made health, safety, conservation, and aeronautics integral parts of the science program. This is in accordance with the recommendations of the *Forty-Sixth Yearbook*:

"*What is the place in the science curriculum of conservation, aeronautics, physiology, and health education?* The materials of these areas are of value chiefly for general education. Except, perhaps, for an eighth-grade one-semester course in health and physiology, it is probably not desirable to offer separate courses in any of these subjects. Their materials can be more effectively integrated with those of the regular courses of the science sequence and with other courses in the program of studies."—p. 46

"The content of the science program in many elementary schools is now being organized around problems which have social value and which are significant in the lives of children. These problems arise from children's

interest in the world around them and from their need to meet intelligently their problems of living in areas such as health, conservation, and safety. They are solved not through the mere accumulation of facts but in such a way as to help children (1) develop meanings which are essential to social understanding, and (2) put into practice desirable social behavior. Problems involve meanings in their solution, and meanings are learned through experiences."—pp. 69–70

"A program in science should develop a large background for the teaching of health. Many schools are now integrating health entirely with science and the social studies. Science provides much of the background for the teaching of health facts and the development of health habits. Moreover, in their study of science, pupils should gain a vision of the potentialities of science in the improvement of the health of the nation and the world."—p. 76

"Likewise, science is involved in accident prevention and safety instruction. We cannot fully anticipate the environment of the future. New inventions may eliminate present hazards and create new ones, making it impossible to develop a code of conduct in safety instruction which will be functional for an entire life span. It may be well, then, in safety instruction to place more emphasis upon the scientific principles which are basic to safe conduct."—p. 77

"The place of science in bringing about the wise utilization of natural resources to the welfare of mankind is an important aspect of the science areas related to the social needs."—p. 77

Health lessons throughout The How and Why Science Books are not labeled as such but take their places naturally as a part of the science program. They are taught also by implication in the illustrations. If health concepts are included in a science book, children learn to assume a scientific attitude concerning health problems. Many science problems are also health problems. The use of the thermometer is taught in science, and it has many implications for health. The germ theories of disease, contagion, and quarantine are all science subjects that are important in health.

Safety is taught both in connection with health and as a part of scientific procedure.

Many activities in science may contribute to the goal of conservation education. Appreciation of the natural and physical world (one of the objectives of all science teaching) should lead

to conservation of wild life and other natural resources. Throughout the books of The How and Why Science Series are such stories as "We Need Soil," "Insect Catchers," "Plants Depend on Animals," "Animals Depend on Plants," "Use—Don't Waste." As in the case of the health and safety lessons, the conservation material takes its place naturally as a part of the science program.

Although World War II gave an added importance to the subject of aeronautics, and a considerable number of separate courses in this field are being taught, chiefly in the senior high school, the authors of The How and Why Science Series believe that this subject can be more effectively integrated with the regular science course. Beginning in the Pre-Primer, the books of the series provide valuable and adequate instruction about the science of flight. Again, this material takes its place as a part of the science program in the study of air and its properties.

THE PLAN OF THE PRIMARY SERIES

SCIENCE THROUGH STORIES AND PICTURES

The books of The How and Why Science Series have a wide scope, including the fields of natural science, physical science, and human science.

The plan of the primary books is to tell stories dealing with the interpretation of natural phenomena common to the experience of children. Science is just as exciting as any other body of subject matter if told in a way that appeals to children. However, the restricted vocabulary of the early grades is often a handicap in presenting what are really simple science concepts. Such concepts can be taught effectively by pictures. In fact, before children can read the words, they enjoy looking at the pictures, and may learn science concepts from them. The books of The How and Why Science Series are beautifully and effectively illustrated. The pictures are reproduced from original water-color paintings by a method so faithful in its reproduction that the illustrations in the books seem themselves to be original paintings.

Nowhere is there a better expression of what appeals to children in the way of books than in the opening chapter of *Alice in Wonderland*:

> "Alice was beginning to get very tired of sitting by her sister on the bank, and of having nothing to do. Once or twice she had peeped into the book her sister was reading, but it had no pictures or conversation in it, and 'What is the use of a book,' thought Alice, 'without pictures or conversation?' "

The books of The How and Why Science Series have *pictures* and *conversation.* The pictures are accurate and beautiful. The conversation is natural and interesting.

THE ORGANIZATION OF MATERIAL

The early books of the series are organized seasonally although the units may be taught at any time. Biological units to be natural have to be seasonal.

Most scientific principles are too difficult for little children to understand. But they can understand concepts which may grow from year to year until finally they can be put together to make a principle. For example, the principle that living things have certain modifications of structure which make it possible for them to survive is too difficult for first-graders. But they can observe that animals are doing different things in autumn, winter, and spring. In the second grade they learn more about these animals such as ways in which they survive the winter by hibernating, pupating, and migrating. In the third grade they enlarge the idea to include ways these animals are protected so that they do survive, such as fur, scales, and feathers. Thus as children are able to comprehend larger concepts, they gain them. Eventually they will be able to derive the principle that animals have survived through the ages because of modifications in their bodies that make it possible for them to live in the environments in which they find themselves.

Because the authors believe in the problem-solving method of teaching, the material in the outlines is organized in the form of problems. If the teacher keeps these problems in mind as she teaches, purpose will be given to her work.

ILLUSTRATIVE MATERIAL

Environment and individual differences play such an important part in children's science interests that the teacher must be guided by her own group in the choice of problems. Some problems may have to be teacher-motivated because lack of experience on the

part of her group may mean that the children will not initiate them. Once introduced to the material, children should accept it with interest, otherwise it is not suitable for them.

The teacher who has had little science experience will find help in knowing what may interest her group from the suggestions given in this and other Manuals for the series, but *she should always be ready to follow child-initiated activities when they arise.* She should not be like the teacher who, having planned a lesson on buds, was disturbed when Johnny brought in a turtle. "Take it right back," she said. "Today we are studying buds."

Illustrative material should come primarily from the child's own environment, but not exclusively so. In this regard the *Thirty-First Yearbook,* page 148, states:

> "Some have contended that no illustrative material should be used except that which is in the natural environment of the school. This seems to be a very narrow interpretation of illustrative material. In this day when the child listens to the events happening in Antarctica, or other far parts of the earth, in which his environment is spreading out so that the whole world comes into his own home in one way or another, to restrict the illustrative material to local, indigenous objects seems, indeed, to be inexcusable."

The subject matter of The How and Why Science Series has been arranged to appeal to as many different groups as possible. Biological units have been chosen in such a way that different sections of the United States are represented. Illustrative material is taken from the East, the West, the Middle States, and the South, thus broadening the scientific concepts acquired by the children using these books.

VOCABULARY TREATMENT

Background of experience and facility in the use of oral expression are prerequisites to the understanding of printed material but are not the sole factors involved in reading that material. Word pronunciation and mastery are factors of equal importance.

To this end, the authors of the primary books of The How and Why Science Series have constantly kept in mind the problems of vocabulary mastery. Each new word has been checked against the Stone and the Gates standardized lists of vocabulary for the primary grades to determine the level at which the word should

be used. Adequate and consistent growth in expansion of the child's vocabulary, level by level, has been carefully and scientifically planned.

Each sentence in the books has been analyzed with readability in mind. Length of sentence, sentence structure, difficult words, as well as the nature of the concepts involved have been used as criteria for checking readability.

Such minor points as the one dealing with variations have been taken into consideration in writing the text. For example, if the words "help," "helping," and "helpful" were to be used, the base form "help" appeared first when possible. The variations "helping" or "helpful" appeared later. The singular form of a word appears before the plural form when possible. No compound words, contractions, or variants, except those made by adding "s" were used at the first reading level. The introduction and use of such words were carefully planned at each level throughout the series.

As a teaching aid, a list of new words for each book is given in the back of that book, with an explanation of the writers' plan in the introduction, repetition, and use of these words.

Using the latest research on the problem as a guide, the mechanical aspects of the reading have been as carefully worked out in this series as in any basic reading program.

THE COMPANION BOOKS

There is a Companion Book designed to accompany each of the texts. The objectives of each of the primary Companion Books are to:

1. Extend and enrich certain concepts
2. Develop a scientific way of thinking
3. Promote language growth

To arrive at these objectives the following activities have been planned: coloring (governed by knowledge of concept), cutting, pasting, and freehand drawing; matching of ideas; selecting and evaluating ideas; placing ideas in proper sequence; reading statements and matching them with pictures; reading simple problems and solving them; doing simple experiments and recording data by

pictures or other means on their level; doing simple tests of concepts learned.

Most of the activities in the primary Companion Books are ones that primary children can do alone. However, there are a few that will require a little thought on the part of the teacher, and at least some discussion. The authors are convinced that as the children acquire more skills, new learning should take place—that the Companion Books should not be just testing programs but an application of principles and concepts to new situations; that the lessons should require the using of skills which are necessary in gathering scientific data and solving problems to attack problems similar to those the children have read about in the text. The authors are determined that these books shall not be the busy-work type—all coloring, cutting, and pasting. All the work in the Companion Books, if used as designed, should serve as an aid in determining the accuracy of the concepts.

AN OUTLINE SHOWING THE DEVELOPMENT OF CONCEPTS

Although each Teacher's Manual contains a detailed outline for a year's work, it may be helpful here to show in chart form the plan and organization of the entire primary group of the How and Why Science Series.

In an effort to accomplish this purpose, the chart on the next two pages is presented. It is a master chart to show the organization of all five books. An examination of this chart will show that the entire field of elementary science is divided into three main content areas—those of Living Things, Physical Environment, and Health. The horizontal divisions show how the concepts grow from book to book and contribute to principles in the upper grades. Vertically, each column represents in brief the science program presented in a single book.

A large, more detailed chart is published separately. In this separate chart the horizontal development shows in more detail the growth of the concepts, and the vertical columns present more elaborate outlines of the material covered in each book. This separate chart may be secured upon request.

ORGANIZATION OF THE ELEMENTARY SCIENCE PROGRAM IN THE HOW

Content Areas	*We See—Pre-primer*	*Sunshine and Rain—Primer*
LIVING THINGS ANIMALS (*See also detailed chart published separately*) In *WE SEE* these concepts are developed by means of pictures.	There are different kinds of animals. Animals are alive. Some animals will need to be fed in winter. Squirrels, ducks, and turtles all have young. Animals eat many kinds of food. Animals go through changes as they grow.	Animals are affected by the seasons. 1. Animal activities in autumn. 2. Animal activities in winter. 3. People get ready for winter. Animals live in different places, differ in structure, and eat different kinds of food. Animals make tracks in snow or mud by which we can follow them.
PLANTS (*See also detailed chart published separately*)	Plants are alive. Seeds grow when planted. Plants have life cycles. Plants are affected by the seasons—autumn, winter, spring, and summer.	There are different kinds of plants. Plants grow in different places. Plants are affected by the seasons. 1. Trees in autumn. 2. Trees in winter. 3. Trees in spring. 4. Trees in summer.
THE BALANCE OF NATURE (*See also detailed chart published separately*)		Children can make simple homes for animals.
PHYSICAL ENVIRONMENT WEATHER AND SEASONS (*See also detailed chart published separately*)	The earth is made up of land, water, and air. We have day and night. There are different kinds of days. We have four seasons. The change of seasons affects animals, plants, weather, and length of day and night. Air is all around us. We see rainbows in the sky. We see rainbow colors in water.	The land, water, and air are farther away than we can see. We travel on land and water and in the air. Rain, fog, and snow are water. Water has different forms. Length of day and night changes.
THE SKY (*See also detailed chart published separately*)	The sun shines on the earth and makes day. We can see the moon and stars in the sky at night. We are in the earth's shadow at night.	Light from the sun makes us warm. Light from the moon and stars helps you see at night. Sunlight helps things grow.
EARTH STUDY (*See also detailed chart published separately*)	The earth is large. The earth is land, water, and air. Seeds are planted in soil. Air is all around us.	The earth is very, very large. People, other animals, and plants live on the earth. We can travel over the earth.
FORMS OF ENERGY (*See also detailed chart published separately*)	We use electricity in our homes. A magnet pulls some things.	The sun gives us heat.
SOUND (*See also detailed chart published separately*)		
BUOYANCY (*See also detailed chart published separately*)	Boats float on water.	Boats float on water. Kites float in the air.
MACHINES (*See also detailed chart published separately*)	We use machines in our home. Machines make work easier.	A windmill is a machine. Windmills do work.
HEALTH GROWTH CLOTHING BODY—PARTS AND FUNCTIONS CLEANLINESS FOOD POSTURE EXERCISE AND PLAY SLEEP AND REST COMMUNICABLE DISEASES SAFETY REPRODUCTION OF LIFE	Plants and animals need food and air to grow. Wear seasonal clothing. Keep your body clean. Eat the right food. Play out of doors. Cross streets carefully. Do not play in the street. Animals and plants make others like themselves.	All living things need food and air to grow. Seasonal clothing. Ready for school. Good foods. Ways of storing food for winter. Seasonal play. Colds are communicable. Children with colds should stay at home. Going to school. Butterflies reproduce. Bulbs make new plants.

AND WHY SCIENCE SERIES, PRE-PRIMER THROUGH THIRD GRADE

Through the Year—Book I	*Winter Comes and Goes—Book II*	*The Seasons Pass—Book III*
Robins, chickens, moths, butterflies, toads, and mammals all have young. Animals grow and develop. Animals eat different kinds of food and live in different kinds of places. Animals are affected by the seasons. 1. Animal activities in the spring.	Animals are able to survive the changing seasons. 1. Insects 6. Reptiles 2. Spiders 7. Crayfish 3. Fish 8. Mammals 4. Birds 9. Earthworms 5. Amphibians Animal tracks may tell a story.	Animals are protected in many ways. 1. Some animals migrate. 2. Some animals hibernate. 3. Birds care for their young. 4. Some animals are protected by their structure. 5. People help protect birds and pets. 6. People are protected by clothing and shelter. 7. Each animal is fitted to the kind of place in which it lives.
Plants are affected by the seasons. 1. Plants in spring. 2. The bean cycle.	Plants are able to survive the changing seasons. 1. Trees are plants. 2. Seeds are scattered in many ways. 3. Bulbs have stored food which helps them to grow. 4. How seeds grow. 5. How wild flowers survive.	Plants are protected in many ways. 1. Some trees lose leaves and have winter buds. 2. Plants produce new plants in different ways. 3. Plants need soil and water. 4. People help protect wild flowers. 5. Plants need a favorable climate.
A home for water animals.	How to make terraria for caterpillars and spiders. How to make an aquarium.	How to make a terrarium for snails. Aquarium vs. terrarium.
Rivers are enlarged in spring. Heat makes water go into the air. Rain comes from clouds. A thermometer shows how hot or cold the weather is. Wind is air that is moving. Weather changes. Rainbows are made when the sun shines on rain. Rainbow colors may be seen in several places. Fire needs air to burn. The wind, sun, and water affect rocks.	Weather changes. Weather in many places. We read a thermometer above or below zero. Water 1. Evaporation and condensation. 2. Different forms. 3. Effect of lack of water. How clouds are made. Animals and fire need air. The weather vane tells what kind of wind is blowing.	Day and night are caused by the rotation of the earth. Thermometers have many uses. Rainbows 1. Sunlight makes rainbows. 2. Sunlight has all colors in it. Air 1. Air takes up space. 2. Air has pressure. 3. Air expands when heated.
The sun gives heat and light. Colors are in the sunlight. The sun and stars are always shining. Stars are far away. Stars make pictures in the sky. We can tell directions by the sun and stars.	The moon seems to change in size and shape. Star pictures—Big and Little Dippers, Orion, Milky Way The North Star is part of the Little Dipper. The North Star helps us tell directions.	The causes of the moon phases. Constellations—Cassiopeia Dippers Orion Relative sizes of sun, earth, and moon. The needle of a compass points north. A compass helps us tell directions.
Rivers and mountains are part of the earth's surface. We put soil into an aquarium. Seeds need good soil to grow. There are different kinds of rocks.	Tree roots are in soil. Some things dissolve. Some do not. Some things form crystals. Soil holds water that plants use. Caves are made in the earth. The earth is round like a ball. The earth has gravity.	How trees use water from the soil. How soil is made. There are different kinds of soil. How soil is carried. Fossils. Different kinds of rocks have different names.
The wind helps things fly. A magnet will pull things made of iron. Electricity makes some things move.	The sun helps living things grow. The wind does work. A magnet has N and S ends. Electricity makes heat and light.	Heat breaks up rocks. The wind does work. Air pressure can be made to work for us. Lightning is electricity.
		Our ears help us hear sound. A thing must vibrate to make sound.
Some things float. Some things do not float.	Boats float.	
An engine is a machine. Engines do work.	Windmills do work for us. A seesaw does work. Engines help move airplanes. Wheels make work easier.	Levers make work easier.
Living things must have proper care to grow. Proper clothing protects our health. We breathe through our noses. Wash hands to get rid of germs. Germs may make one sick. Cleanliness with food at the seashore. Indoor and outdoor play. Rest after play. Early to bed. Robins, chickens, rabbits, toads, butterflies, moths, and mammals all have young that grow up to be like their parents.	Sunshine helps plants and animals to grow. Seasonal clothing. Care of teeth. Soap and water for cleanliness. What to eat. How to eat. How to stand and sit erect. Play out of doors. How to put out a fire. Insects, plants, amphibians, reptiles, crayfish, squirrels, and birds all have young.	Our bodies need good food, fresh air, and sunshine. Wool, cotton, silk. Eyes, ears, nose, mouth, teeth, skin. Care of skin. Milk and vegetables. Value of good posture. Vacation fun. 8 o'clock for eight-year-olds. Quarantine. How to cross a street. Insects and birds lay eggs. Young mammals are born alive.

THE SEASONS PASS—BOOK III

THE PLAN OF THE BOOK

The Seasons Pass is Book III of The How and Why Science Series. Its main objective is to present science and health concepts through interesting stories and pictures.

In the construction of The Seasons Pass, emphasis has been placed on simplicity of concepts and readability. Concepts introduced in the preceding books of this series have been enlarged and enriched in The Seasons Pass, the third-grade book. The vocabulary has been carefully controlled with respect to the introduction and repetition of new words. Each word has been checked against the Gates and the Stone standardized lists of words for the primary grades. A planned program with regard to word variants, derivatives, compound words, and contractions also adds to the readability of the book. Except for the purely "science" words, this book may be read as easily as any basal text in reading, and often with a great deal more interest. The science words, because of their richness in meaning and distinctive characteristics as to form, are more easily learned than shorter abstract words. Colorful, informative material that may be read with ease at the third-grade level was the major objective in building this material.

SCIENCE CONCEPTS AND PROBLEMS PRESENTED IN *THE SEASONS PASS*

UNIT A. PROTECTION OF PLANTS AND ANIMALS

	Story Titles in *The Seasons Pass*	
Problem I. How does seasonal change in trees make it possible for them to survive?		
1. Changes made by trees in autumn can be interpreted.	"A Trip to the Park"	p. 13

Story Titles in *The Seasons Pass*

a. How do trees look before the leaves fall?
  (1) The elm tree.
    (*a*) There are different parts of a tree. Each part serves a different purpose.
    (*b*) The elm leaf is a simple leaf.
  (2) The horse-chestnut tree.
    (*a*) The horse-chestnut has a compound leaf.
    (*b*) There are buds between the leaves and the twigs.
    (*c*) The path of water in the tree can be traced in the twigs and leaves.
  (3) Food is made in leaves. There is a reason why the leaves change color and fall.

b. Marks on a twig have meaning. — "The Story of a Twig" p. 22
  (1) If a leaf is picked from a twig, a scar is left.
  (2) After the leaves fall, a tissue which has grown across the twigs where the leaves came off can be seen on twigs.
  (3) The age of twigs can be estimated by the number of bud scars.
  (4) We examine buds.

c. Deciduous and evergreen trees.
  (1) There is a way of telling the age of an evergreen.

2. Some ways in which other plants survive.
  a. Some plants live longer than others.
  b. Parts of some plants produce new plants. — "Joyce's New Plant" p. 174
  Slips and cuttings produce new plants.
  c. Many plants store food.

Problem II. How are animals protected?

1. The fur covering gets thicker in autumn. — "Taking Care of Rat Tail" p. 94
  a. Sheep, cows, and horses have fur.
  b. The hair of dog, cat, and sheep may be compared with our own hair.
2. Animals have more fat in autumn.

	Story Titles in *The Seasons Pass*	
3. Domesticated animals are cared for by their owners.	"Taking the Cattle to Market"	p. 80
a. Sheep, cattle, and horses are brought in from the open ranges.		
4. Animals have other interesting structures.	"Bringing Down the Sheep"	p. 85
a. Some animals have hoofs.		
b. The teeth, tongue, and stomach of ruminants are interesting.	"The Deer"	p. 92
5. Some animals migrate.	"Birds in Autumn"	p. 34
a. Some of their migration habits.		
b. Some possible reasons for migration.		
6. Some animals hibernate.		
a. Frogs, toads, and salamanders hibernate in mud, dirt, or decaying logs.	"Where Are the Frogs?"	p. 41
b. Earthworms hibernate.	"No Earthworms"	p. 46
c. Female bumblebees and wasps hibernate.	"A Surprise"	p. 54
	"Another Surprise"	p. 56
d. Some butterflies and other insects hibernate.	"Other Insects that Hibernate"	p. 58
e. Snails hibernate.	"The Snails"	p. 61
f. Woodchucks and bears hibernate.	"High in the Mountains"	p. 100
	"The Woodchuck"	p. 107
7. Birds make nests in which to bear their young, not to spend the winter or live in.		
a. Different materials are used by birds in making nests.	"A Nest Hunt"	p. 71
b. There are many places where nests are built.		

PROBLEM III. How do our eyes, ears, nose, mouth, and teeth help us?	"Four Senses"	p. 64
	"Jack's Teeth"	p. 96

1. Sight is one sense.
   - *a.* Eyes are important.
   - *b.* How to take care of them.
2. Smell is a sense.
   - *a.* One's nose is important.
   - *b.* Rules for taking care of one's nose.
3. Taste is a sense.
   - *a.* One's mouth is important.
   - *b.* How to take care of one's mouth.
4. Hearing is a sense.
   - *a.* Ears are important.
   - *b.* How to take care of one's ears.

	Story Titles in *The Seasons Pass*	
5. Teeth are very important.		
a. There are three kinds of teeth in each jaw.		
b. Adults have twenty-eight or thirty-two teeth.		
c. Rules for taking care of our teeth.		
PROBLEM IV. How do health laws help prevent spread of disease?	"The Doctor Comes"	p. 114
	"Reading Thermometers"	p. 119
1. What quarantine is.		
2. People are quarantined for such diseases as scarlet fever and diphtheria.		
3. People are not quarantined for colds but they should stay away from people when they have colds.		
PROBLEM V. How are skeletons useful?	"Trips with Cowboy Hal"	p. 111
1. Bones make the shape of the body.		
2. One could not run, sit up, or stand up without bones.		
3. Milk, eggs, lettuce, beans, and spinach are foods which help make bones grow.		
4. Sitting and standing straight help bones grow straight.		

UNIT B. WEATHER

PROBLEM I. How can weather be interpreted?		
1. Air is a factor of weather.	"Air"	p. 122
a. Air is colder in winter than in summer.		
b. Air occupies space.		
c. Air presses in all directions.		
d. Air expands when heated and contracts when cooled.	"Why Susan's Balloon Burst"	p. 131
e. There is moisture in air.		
f. Air can be used to do work.		
2. Sun is a factor of weather.	"Reading Thermometers"	p. 119
a. The sun is the source of heat that makes air expand and water evaporate.	"Day and Night"	p. 156
b. The earth's turning on its axis makes day and night.		
c. The sun heats the earth, the earth heats the air, and the warm air makes the thermometer rise.		

UNIT C. SOUND

	Story Titles in *The Seasons Pass*	
PROBLEM I. What makes sound?	"What Makes Sound?"	p. 136
1. A thing must vibrate to make sound.		
a. When a rattle vibrates it makes sound.		
b. When a drum vibrates it makes sound.		
c. When the reed in a horn vibrates, the horn makes sound.		
d. When a bell vibrates it makes sound.		

UNIT D. THE WINTER SKY

PROBLEM I. What heavenly bodies can be seen at night?		
1. The moon can be seen at night.	"The Moon"	p. 161
a. There are reasons for its apparent change in shape.		
b. It takes time for the moon to revolve.		
c. The sun makes the moon shine.		
2. There are groups of stars called common constellations.	"Jimmy's Star Pictures"	p. 166
a. The Big and Little Dippers are common constellations.		
b. Orion and the Dog Star are familiar.		
c. Cassiopeia looks like the letter W.		
PROBLEM II. How do the sun, the moon, and the earth compare in size?	"The Moon"	p. 161

UNIT E. ANIMALS IN WINTER

PROBLEM I. How do winter birds survive?		
1. Some birds are insect-eaters.	"Beaks and Feet"	p. 146
a. Brown creepers, nuthatches, chickadees, and downy woodpeckers are insect-eaters.		
b. Suet, nutmeats, and meat scraps may be fed to these birds.		
2. Some birds are seed-eaters.	"Beaks and Feet"	p. 146
a. Juncoes, goldfinches, and cardinals are seed-eaters.		
b. Seeds and crumbs may be fed to these birds.		
3. Some birds are ground-feeding birds.	"A Ground Bird"	p. 144
a. Quail and horned larks eat on the ground.		
b. Seeds and grain may be fed to these birds.		

	Story Titles in *The Seasons Pass*	
Problem II. How can one learn about winter birds?		
1. A record of birds seen at the feeding shelf.	"The Winter Lunch Counter"	p. 140
a. List of the foods eaten.		
b. Changes noted in color of the birds that have different plumage in winter such as the goldfinch.		
2. There are different types of feeding shelves.	"How to Make Feeding Shelves"	p. 151
a. Swinging shelves frighten sparrows.		
b. Covered shelves keep off snow.		
c. Different shelters can be made for ground-feeding birds.		
Problem III. How do people keep warm?	"Jack's Clothing"	p. 168
1. Our bodies make heat.		
2. Our clothing keeps the heat in.		
3. Bed clothes keep the heat in at night.		
4. Wool prevents the escape of heat more than cotton does.		
Problem IV. How should a pet be given care?	"Jimmy's Puppy"	p. 178
1. A dog makes a good pet but requires care.	"My Cat"	p. 186
2. Cats and dogs are something alike. They are meat eaters. They differ in the way they get their food.		
3. Cats should be watched to keep them from killing birds.		
Problem V. How should foods be chosen?		
1. Milk is a good food.	"Dick's Cow"	p. 187
a. How to care for milk.		
b. How to make butter and cheese.		
2. Eggs, vegetables, fruit, and meat are good foods.	"Bob Goes to the Store"	p. 196
3. The function of food in the body is important.		

UNIT F. THE EARTH

Problem I. How do rocks help us interpret the story of the earth?		
1. Fossils are pictures in rocks.	"Pictures in Rocks"	p. 200
a. How were fossils formed?		
b. Where may some fossils be found?		

	Story Titles in *The Seasons Pass*	
2. There are many different kinds of rocks.	"Rocks Have Names"	p. 205
a. We study limestone and learn how to recognize it.		
b. We study different kinds of sandstone.		
c. We learn how to recognize shale.		
3. There are tides in the ocean.	"The Seashore"	p. 262
PROBLEM II. How is soil made?		
1. We study the formation of soil.	"How Soil Is Made"	p. 209
a. We see erosion caused by melting snow and little gutter streams from rains.		
b. We notice the wind blowing the soil.		
c. We hunt for pebbles showing the effects of water, wind, or glacial action.		
d. We separate disintegrating rocks according to their softness and crumble them to see what kind of soil comes from each.		
2. We study different kinds of soil.	"We Need Soil"	p. 212
a. We collect sand, clay, and humus. We mix them to make loam.		
b. We examine soils for their texture, color, and ability to hold water.		
3. We study the relation of soil to plants and animals.		
a. Plants help to make soil.		
b. Soil is necessary for plants. Plants use the minerals in soil, water, and decayed plants.		
c. Earthworms help make soil.		
d. We grow seeds in different kinds of soil to find out which is best.		
4. The earth's surface is constantly being changed.	"How Soil Is Carried"	p. 221
a. Soil is carried from one place and deposited in other places. Rivers and valleys are being formed. Dust storms are changing the earth.		

UNIT G. CARE OF THE BODY

PROBLEM I. Why do we bathe?	"Jack's Bath"	p. 269
PROBLEM II. What is perspiration and its purpose in the body?	"Jimmy Learns about His Skin"	p. 224

UNIT H. LIFE CYCLES OF BIRDS AND INSECTS

	Story Titles in *The Seasons Pass*	
PROBLEM I. How do some common birds care for their young?		
1. We study the following birds.		
a. Cardinals	"The Cardinal's Family"	p. 226
b. Bluebirds	"House for Rent"	p. 235
c. Barn swallows	"Insect Catchers"	p. 250
d. Red-winged blackbirds	"The Red-winged Blackbird"	p. 258
e. Meadow larks	"A Friend of the Farmer"	p. 270
PROBLEM II. What is the life cycle of a butterfly?	"The Life of a Butterfly"	p. 32
PROBLEM III. How are silkworms raised?	"The Life of a Silkworm"	p. 242

1. We learn about the care of eggs.
2. We care for the young caterpillars which are fed on mulberry leaves.
3. We watch the caterpillars molting and growing.
4. We see them spinning.
5. We watch the reeling of silk.
6. We see moths emerging from cocoons.
7. We watch moths mating and laying eggs.

UNIT I. WILD FLOWERS

PROBLEM I. How can we know and protect wild flowers?	"Spring Wild Flowers"	p. 254

1. We discover places to find wild flowers.
2. We learn what ones may be picked and how they may be picked.
3. We learn about wild flowers in different parts of the country.

UNIT J. HEALTH AND SAFETY HABITS

PROBLEM I. How can good health habits be performed?	Ted's Health Rules	p. 285

1. Hands should be washed before eating and after going to the toilet.
2. One should never use another person's cup or handkerchief.
3. One should have clean fingernails.
4. One should not eat between meals.
5. One should clean his teeth.
6. One should keep his room clean.
7. One should hang up his clothes.

8. One should remember daily bowel movements.
9. One should take a daily bath.
10. One should go to bed at eight o'clock.
11. One should cross the street carefully.

UNIT K. WOOL

PROBLEM I. How do we get wool? "Getting Wool from Sheep" p. 265

1. How sheep are sheared.
2. How wool is loaded.
3. How sheep are dipped.

UNIT L. WEATHER

PROBLEM I. What causes lightning and rainbows? "A Spring Shower" p. 274

1. Lightning.
   a. Lightning is a big spark of electricity that jumps through the air.
2. Rainbows.
   a. Sunlight has all the colors in it.
   b. All the colors may be seen by holding a prism in a ray of sunlight.
   c. There are seven colors.

UNIT M. MACHINES

PROBLEM I. How can work be made easier? "Off to Camp" p. 280

1. Men have made tools to help them do work.
2. There are several kinds of machines. Levers and wheels are machines.
3. People use natural forces to help them in their work. They use water wheels, windmills, and fuels which they get from nature.

ACTIVITIES USEFUL IN SOLVING THE PROBLEMS IN *THE SEASONS PASS*

BACK TO SCHOOL

Pages: 4–11

The first story in The Seasons Pass illustrates a good introductory lesson for the beginning science year. It shows how the teacher may draw on the children's experiences to start off their science interests.

Children enjoy telling about the things they have seen and collected. Their curiosity is stimulated and more careful observation is developed if they are encouraged to discuss these experiences. Also, they learn from the shared experiences of others. If children are given an opportunity at the beginning of each science lesson to tell these things, they feel that they have contributed to the class discussion. It helps correct a situation which may otherwise arise when these irrelevant happenings are related during the lesson. These "science meetings" should be directed in such a way that a few children do not monopolize the conversation. If the class is large the teacher may say, "Since there are so many in this class and since we want to hear from each person, let each one think of the most interesting (or most important) thing he would like to tell about." Or if it is a daily procedure, "Some people didn't have a chance to tell their experiences yesterday. Shall we let them start first?"

Such an exploratory lesson may be used by the wise teacher, not in a hit-or-miss program of science, but as motivation for well-planned units.

A TRIP TO THE PARK

Pages: 12–21

Concepts:

Leaves of many trees change color in autumn.

Trees keep their same trunks and branches from year to year though their leaves may fall.

Roots of trees spread a long way from the tree.

Water comes into the roots, goes up the trunk, and into the leaves.

The kind of tree may be told by its leaves.

The leaves make food for the tree.

Trees use some of this food and store the rest.

Suggested Activities:

This story is intended to teach something about the activities of plants. A tree is a good plant to use because it lives more than one year, has parts large enough to be seen easily, and is interesting to children. Even in cities where gardens are rare, there are trees in the parks.

We usually think of two types of trees, the evergreens and the deciduous trees. In autumn, changes are taking place in both types, but they are more evident in the deciduous ones.

The roots of a tree are the organs of absorption. Water enters the root hairs by a process called osmosis. It travels up through the water-carrying cells (xylem) of the vascular tissue. This vascular tissue is just under the bark. When the water reaches the leaves it is used in making food.

The process of food-making is too difficult for little children to understand but they can begin to learn something about the parts of a tree. The roots anchor the tree and absorb water through root hairs. The trunk or stem is the transportation organ through which water travels upward and the sap downward. The leaves are the food-making organs of the tree. These facts may be illustrated by any plant which may be pulled up and examined.

Deciduous trees have two types of leaves, simple and compound. In the story, simple leaves are represented by elm leaves and compound leaves by horse-chestnut leaves.

A simple leaf has one blade to a leaf stem (petiole). The blade is the broad part of the leaf, the petiole is the stem part. There is always a bud in the axil of the leaf, that is, between the petiole and stem. A simple leaf may be entire like a lilac leaf or lobed like a maple.

Compound leaves have several leaflets to each petiole. It is as if the blade had been cut in until there are leaflets instead of lobes.

Leaf characteristics help us to know trees. Children should find leaves that illustrate the points of the story.

If horse-chestnuts or buckeyes don't grow in the region, the teacher may use any deciduous tree for illustration. The larger the buds, the easier it is for the children to study them. Hickory, ailanthus, and sycamore trees have large buds and scars. If they are observed before the leaves fall, let each child pull a leaf from the twig to see how the petiole fits the scar.

The children in the class should try to read the stories that are told in twigs just as the children in the book do. They should notice what happens as the corky layers of tissue grow across the leaf petioles. As these layers grow, the leaves may change color. This helps youngsters to realize that it is the lack of water in the leaves rather than frost that causes color changes.

If hand lenses are available, the children may look at the ends of leaf petioles to see the little holes through which water passed to the leaves. To demonstrate how water travels through the leaf stem, this experiment may be done.

Dissolve enough red or green food coloring, or Easter-egg dye, in water to make a deep color. Cut a stalk of celery *under* the solution and let it stand in the liquid. Before long the vascular tissue will be stained, even in the leaf veins. The part of celery which we eat is the petiole of the leaf. After coloring, cut thin cross sections of the stalk and let the children examine them with their magnifying glasses. The vascular tissue will show up as colored dots.

When the corky layers are complete, a wind will easily detach the leaves from the trees. Then children should note the covering that has grown over the leaf scar—a protective covering for the scar. They should also notice the protective coverings on the buds. These coverings protect more from evaporation than freezing. During the winter, water is at a premium.

Since these children are too young to understand that chlorophyll in the leaf has been working all summer to make sugar and starch for the tree, they can't understand the color changes. Water being cut off, chlorophyll dies. When it disintegrates, it unmasks

the yellow. Yellow is always there. Grass that has been covered with a board illustrates this. The red is a pigment that may be produced by chemical changes of minerals and sugar that have remained in the leaf.

This story helps contribute to the principle that plants go through seasonal cycles. It helps contribute also to the principle that plants are able to survive because of certain modifications.

If evergreen trees grow in the region, the children may compare the leaves with those of a deciduous tree. The petiole of a pine needle is very small, and leaves a tiny scar when it drops. Contrary to popular ideas, evergreens *do* lose their leaves, but not all at one time. In the fall the pine trees have many brown needles on them. A good wind will scatter these dead leaves.

The buds of evergreens are on the ends of the branches. In the spring when these swell and open, bunches of soft, light-green needles come out. The tip of the trunk grows and produces a whorl of new branches. That is the reason that the age of an evergreen can be estimated by the number of whorls, adding three because the branches of the first two or three years would be so small that they would be broken off by the time the tree is any size.

THE STORY OF A TWIG

Pages: 22–31

Concepts:

Buds are made on a tree before the leaves fall.
Buds have protective coverings over them.
Buds contain stem tips, leaves, and flowers.
Buds remain alive through winter and start growing in the spring.
The age of a twig may be told by the bud scars.

Suggested Activities:

Seasonal cycles are manifested in trees in several ways. One way is by the changing color and falling of the leaves. Before the leaves fall, enough food has been made and stored to keep the tree alive during the winter and supply the buds with enough food for development in the spring.

"The Story of a Twig" is intended to further contribute to the

principle of adaptation. The sticky substance on the outside of the buds that prevents evaporation helps keep the bud alive. The tiny leaves and flowers inside the bud, formed while there was still plenty of food, and the protective layer that grows over the leaf scar as the leaf is cut from the twig also contribute to the life of the tree.

Children should observe all of these things and try to find everything that will help them interpret the life history of a tree.

By finding different twigs of the same length and comparing the number of bud scars, they will discover variation in amount of growth. For example, the first twig on page 26 is over three years old, the next one five. But another twig from the same tree might be shorter yet older. That should raise interesting discussions concerning the reasons for such inequality of growth. Some of these are differences in weather, the place the tree is growing, and even the side of the tree the twig is growing on. Let children give their ideas and discuss possible reasons for this variation in rate of growth. Water supply, sunshine, soil, and weather all have their effect.

The twig at the top of page 27 is over six years old and the second one is over nine years old, though they are nearly the same size.

Of course one can't tell the exact age of a tree even by the annual rings. But one can estimate the age of an evergreen by counting spaces between whorls of branches and adding three.

The difference in branching of deciduous and evergreen trees is that an evergreen has a main trunk. Deciduous trees have the main trunk branching. The buds of evergreens are on the ends of the branches. The straight main trunk was formerly used for masts of ships.

THE LIFE OF A BUTTERFLY

Pages: 32–33

The purpose of these pages is to review the life history of a common butterfly, the Tiger Swallowtail. The children may compare it with the Black Swallowtail (carrot worm butterfly). They will see similarities which characterize the swallowtail family.

If possible children should care for butterfly larvae and watch them go through their transformations. Tiger swallowtail larvae may be found feeding upon birch, poplar, ash, wild cherry, and other trees and shrubs. They vary in color from olive to dark green and have an interesting habit of weaving a carpet of silk upon which they rest when not eating. The adult may be black and yellow or nearly all black.

The mating of many insects takes place in the air and children may learn the concept of mating in a very wholesome and normal way by watching insects mate. When they see this happen and ask about it, simply say, "The male and female butterfly are mating. You know that a female butterfly lays eggs. Before the eggs are laid they are fertilized by the male. That is the way he does it." Usually that is enough for third-graders but if they inquire further, the teacher may say, "Eggs won't hatch unless they have something to start them growing. The male butterfly has a liquid in his body which starts the eggs growing. He puts it into the female's body before she lays the eggs."

These pages are to fix in children's minds the cycle of egg, larva, pupa, and adult. The children should observe this cycle with as many kinds of butterflies as possible so that they realize that though butterflies vary in their appearance, they all pass through the same cycle.

BIRDS IN AUTUMN

Pages: 34–39

Concepts:

Many birds migrate in autumn.

People have many incorrect ideas about bird migration.

Scientists don't know everything about birds. They have some ideas about the reasons for migration but they do not know whether these ideas are correct.

Suggested Activities:

Bird migration has always been a mystery to man. For that reason many unscientific and inaccurate explanations have been given. This story is intended not only to give some of those ex-

planations but to show children that not all natural phenomena have been explained. It should help develop the scientific attitude of not drawing conclusions from insufficient evidence.

The teacher should direct observation toward the flocking of birds, the disappearance of some, the remaining of others. The children should raise problems and suggest possible explanations, but they should support their theories with sound evidence or else conclude that this is something yet to be solved.

Problems may arise in the way suggested in the story. If children have developed the attitude of sensitive curiosity and have been encouraged to ask questions concerning the things they wonder about, problems will arise spontaneously. If this is not the case, the teacher may have to motivate such an activity. She may say, "I noticed a flock of bluebirds in my yard this morning. They were eating the berries on my high-bush cranberry. I wonder where they came from." Or she may call the attention of the children to a flock of robins on the school lawn, or to the bushes full of warblers. In the discussion, the children should be encouraged to tell of similar experiences until the teacher thinks the time is ripe to say, "We have all been seeing birds doing interesting things. But I would like to know why they are doing some of these things. Do any of you want to know more about them?"

When children are accustomed to the problem-solving method, they will usually ask good questions. If not, the questions may have to be culled. They should all be put on the board the first time this is done and the children allowed to select those which are worth spending time on. They will discover that some overlap and can be included in one question; that some are more important than others; and so on.

In the story the children selected four questions for Dick's father to answer. This illustrates one technique in problem solving.

By interviewing someone who knows more than they do, children help to solve their problems. But they should not stop there. They should go on field trips to observe birds flocking, observe individually and report to the class, and read any references on their level of understanding. Eventually they should arrive at the

conclusion that though ornithologists are experimenting to try to explain migration, it is not yet a settled question. The teacher should read what an authority has to say on the subject before trying to discuss it with the children. Several good references are given at the end of the Manual. This chapter teaches concepts that are basic to understanding a theory, but at this level we don't use the word *theory.*

WHERE ARE THE FROGS?

Pages: 40–45

Concepts:

Frogs and toads hibernate in winter.
Frogs hibernate in the mud.
Toads hibernate in holes in the ground.
Salamanders hibernate in logs, under stones, and in other damp places.
Snakes and lizards hibernate under stones or logs or in holes made by other animals.
Animals do not eat while they are hibernating.

Suggested Activities:

This story opens a unit on hibernation. All cold-blooded animals and a few warm-blooded ones hibernate in winter. In the first books of this series the children's attention was called to some of these animals, but the word *hibernation* was not introduced until in WINTER COMES AND GOES. We said that the animals rested.

Actually, hibernation is a dormant state in which the animals' life processes are all slowed down. Breathing is so slow in some as to not be noticeable. The heartbeat is very slow. If a hibernating frog or snake is picked up, it seems cold and dead.

Frogs, toads, salamanders, turtles, and snakes may all be kept in a hibernating cage in a cool room. Then the children can watch them go into hibernation. Of course one wouldn't put snakes in the same cage as frogs or toads because the snakes might swallow the frogs or toads.

A hibernating cage simply has dirt at one end and at the other end a pan of water with sand enough in it for an animal to bury itself. If the dirt slopes down to the water it will keep moist.

These animals may be kept in a terrarium similar to the one described on pages 50 and 51. Some moss and pieces of bark should be provided for salamanders to crawl under.

One third-grade group experimented with a toad. They filled a good-sized box with garden soil to within about three inches of the top. They put a pan of water in one end. They put the toad into the box and tacked a wire-netting cover on the box. Then they dug a hole under a bush in the schoolyard and put the box into the hole. The top of the box was flush with the ground. The wire netting allowed insects to get into the box as long as the weather was warm, and the children kept water in the pan. This was done in autumn, shortly before the toads would normally go into hibernation.

Following the first good snowstorm the snow was removed from the box, the netting taken off, and a search made for the toad. It was buried in the dirt, stiff and cold. When brought into the warm room it slowly revived with twenty-five fascinated and rather awed little boys and girls crowding around the table. The suggestion that it be put back into its cold bed out of doors brought a storm of protests. So it was a pet in the terrarium for the rest of the winter.

In case a teacher wishes to keep an amphibian or reptile in the schoolroom all winter she will need to raise live insects to feed it. Mealy worms and other beetle larvae are easily raised in a glass jar. Crumble a piece of newspaper in the bottom of the jar. Cover it with bran or oatmeal. Put an apple or carrot on top of this and a few mealy worms, weevil larvae, or other beetle larvae on the bran. Fill the jar with bran, cover the jar loosely, and keep in a dark place.

During hibernation, amphibians get oxygen through their skins and use the food stored in their bodies. Their skins must be moist to allow the oxygen to enter.

NO EARTHWORMS

Pages: 46–53

Concepts:

Earthworms dig deeper into the ground as the weather gets cold.

Land snails live in woods. They may be fed lettuce in a terrarium.

A terrarium is a home for small land animals.

Suggested Activities:

A way to keep earthworms in a crock of garden soil for easy observation has already been described. The children may also fill a half-gallon glass jar with soil. Put some earthworms on top of the soil. The children can notice how long a time will pass before the earthworms burrow out of sight. Place black paper around the jar. In a few days remove the paper. The children will be able to see the burrows that the earthworms have made.

The children will inquire about the little piles of subsoil which the worms bring to the surface. These are called *castings.* As the earthworms burrow into the soil, they swallow some of the soil along with their food. This soil is ground fine in their bodies and is deposited on the top of the earth in little piles. Charles Darwin once said that in England earthworms bring to the top of the earth each year eighteen tons of soil per acre. The children can thus be made to realize the economic importance of earthworms.

Terrarium is introduced in this story as a home for land snails. In many places land snails of different kinds and sizes are common. Most of them are easily kept in a terrarium and their activities observed. The children should notice how they move up the sides of the terrarium, leaving a silver path of mucus behind them. One form of land snail, the garden slug, is a pest in gardens. Slugs have no shells into which they can draw themselves, merely a small plate of shell-like material on their backs.

A SURPRISE

ANOTHER SURPRISE

OTHER INSECTS THAT HIBERNATE

Pages: 54–55; 56–57; 58–60

Concepts:

Some insects hibernate.

Queen bumblebees hibernate.

The other bumblebees die in autumn.

Queen wasps hibernate.
The other wasps die in autumn.

Suggested Activities:

Hibernating wasps and bumblebees are often found under logs or in decaying wood. Sometimes the paper nests of wasps are brought in and the children wonder what is happening to the wasps. As the nest warms up, wasps may come crawling out. These are the workers that would die as winter comes. The queen leaves the nest before it gets cold and crawls away into some protected place. Bumblebee queens stay in their nests in the ground, in holes in logs, or in other hiding places. They often make their nests in deserted nests of meadow mice.

Some of the other insects which hibernate are box-elder bugs, those black and scarlet bugs which often come into buildings in droves to hide in cracks and under boards. Children call them "brick" bugs because they sometimes cover the brick foundations, almost camouflaged by their resemblance to the bricks.

The butterflies that hibernate as adults include not only the ones that migrate like the Monarch, but also ones like the Mourning Cloak, the Red Admiral, and the Painted Lady. The Mourning Cloak is the one illustrated on page 60. All of these butterflies belong to a group known as the anglewings and are common in most parts of the United States. In winter they are sometimes found clinging to walls or rafters in garages, barns, or other buildings.

The label on page 60 is not meant to be read by the children. The butterfly is so named because of the light-bordered, dark-colored wings.

THE SNAILS

Pages: 61–63

Concepts:

Land snails hibernate.
Snails are protected by their shells and a material which closes the opening in winter.
Hibernation protects animals through the winter.
Many kinds of animals hibernate.

Suggested Activities:

A bulletin board may be made to summarize the study of hibernation. The word *hibernation* might be printed in the center of the board. Radiating from the word, strings might lead to pictures of animals which hibernate. This could be used as the animals are studied or at the end of the activity.

The generalization that children may make from observing many animals before and during hibernation is that in the winter when food is hard to get, some animals are protected by hibernating; that during hibernation animals seem to be sound asleep or dead; that in this state their breathing and other activities are so slowed down that little food is needed.

Most of the animals which hibernate are cold blooded; that is, their temperature changes as the temperature around them changes. Birds and mammals are warm blooded; that is, their temperature remains constant. No birds, and very few mammals, hibernate. Woodchucks hibernate, and it has been found that their temperature is reduced during hibernation.

FOUR SENSES

Pages: 64–70

Concepts:

Sight, smell, taste, and hearing are four senses.
Eyes, nose, mouth, and ears make the senses possible.
We need to know how to care for the eyes, nose, mouth, and ears.

Suggested Activities:

Children take their bodies for granted and often carelessly injure or otherwise harm them. While we do not wish to place undue emphasis on this phase of health teaching, a better understanding of the sense organs may help to stress safety.

Let the children look at their own eyes in a mirror or at the eyes of another child. The teacher might introduce the concept of protection by saying, "We have watched many kinds of animals. What are some of the things we have learned about them?" The

children may say, "How they spend the winter. How they move, eat, and so on." Then the teacher may say, "But we haven't thought much about the most interesting animals in this room. They need to be protected, also." Following this line of thought, she can lead the children to suggest themselves as interesting animals. They may discuss ways that they need protection—the fact that they need to care for their eyes and protect them from eye strain, injury, and infection.

If field glasses have been used in watching birds, or a magnifying glass used for examining a feather, snowflakes, or butterfly wing, the children will be interested in knowing that lenses are back of the pupils in their eyes.

To impress upon their minds the importance of good eyes, a seeing game may be played. Take the children outdoors and all standing together for two or three minutes, try to see as many things as possible. Tell them not to say a word, just to try to remember what they see. Then go back into the building and make a list of all the things seen by the whole class.

A smelling game may be played, also, blindfolding a child and letting him smell and name various things by their odor. Such things as mint, fir needles, a rose, and an apple are good to use.

Following a study of the senses the school nurse may talk to the children on care of the eyes, ears, nose, and mouth.

A NEST HUNT

Pages: 71–79

Concepts:

- Birds make characteristic nests which may be recognized by an ornithologist.
- Autumn is the only time we should collect nests.
- Some birds make well-woven nests while some make very flimsy ones.
- Birds use many different kinds of materials in their nests.

Suggested Activities:

Autumn is a good time to study bird nests. Although many birds come back to the same territory year after year, few use the

same nests. Birds may build new nests on top of old ones or use materials from the old nest to construct new ones, but there is no harm done by collecting deserted nests. As suggested in the Manual for WINTER COMES AND GOES, this is a good way to satisfy children's curiosities concerning nests without disturbing nesting birds.

This story is intended to add to the children's growing concept of the principle of adaptation. They discover that some birds make their nests in holes, some use mud, some grass, some twigs and other materials. The children should find different nests and notice where they are built. They should discuss the advantage to the bird of each type. The teacher should be sure that the children do not think that the birds have a purpose in using these different materials. It is simply an inherited characteristic. An oriole always makes a hanging nest woven of some fibers, but she will use any fibers that are available. A red-winged blackbird living in a cat-tail swamp will use the cat-tail leaves for her nest but in some places the same bird may use other grasses. However, the nest is always partially hanging and woven around the support. Within a species, birds have the same nesting habits.

After studying nests where they were built, children might collect one of each type and label each for an exhibit. The nests may be arranged in order of the complexity of their structure from the simplest to the most elaborate. The nests in the story would be arranged in this order: mourning dove, robin, barn swallow, goldfinch, red-winged blackbird.

Another interesting activity is to take a nest apart, naming each kind of material. These may be mounted on the bulletin board, with the name of the bird making each nest under the group of materials used in it.

As they name the materials the children should discuss the use each material would serve. For example, in the swallow's nest the mud is cement, the hairs hold the mud together, and the feathers make a soft lining for the fledglings. The red-wing's nest is strongly anchored to the cat-tail stems with the stout leaves. Rising water wouldn't be so likely to make it float away. It, too, is softly lined with fine grass and the bottom is thick.

TAKING THE CATTLE TO MARKET
BRINGING DOWN THE SHEEP
THE DEER
TAKING CARE OF RAT TAIL

Pages: 80–84; 85–91; 92–93; 94–95

Concepts:

Cattle are used for beef and dairy products.
Beef cattle are heavier and more solid than dairy cattle.
Cattle must be well cared for to keep them in good health.
Calves are born alive and fed milk by their mother.
Sheep are used for their wool and for meat.
Wool keeps the sheep warm.
Cows, sheep, and goats have split hoofs.
They all chew cuds.
Lambs and kids are born alive and get milk from their mothers.
Goats' milk is used for human food.
All of these animals have teeth fitted for grinding their food.
Deer are wild cud-chewing animals.
Young deer are fawns.
Horses are used for beasts of burden.
Horses do not chew cuds.

Suggested Activities:

These stories are intended to bring out the protective adaptations of the order of mammals known as *Herbivora.* To this order belong cattle, sheep, goats, deer, horses, and donkeys. There are two groups of these that are sometimes known as the even-toed and odd-toed mammals. The even-toed ones, with the exception of pigs, chew a cud. The odd-toed ones do not chew a cud.

In teaching about any animal the teacher will find it more interesting and effective if she continually has the children compare these animals with themselves. Thus they learn about their own teeth by studying the teeth of the various orders of mammals.

If possible, the children should visit a farm and see these animals. They may compare a dairy and a beef animal, contrasting the broad back and heavy body of a beef cow with the shape of the dairy cow.

Watch the cow eating and chewing her cud. A cow's stomach has four sections, so to speak. As the cow eats, the food goes into one section in which it is stored for future chewing. When the cow is through eating, the food passes into a muscular portion of the stomach, which regurgitates it in small portions. As each portion is chewed, it goes into the third and fourth parts of the stomach for final digestion.

These pages also teach the correct words for the young of cattle, sheep, goats, and deer. The word *baby* is properly applied only to human beings. The fact that these animals all nurse their young makes them mammals. The concept that the young are born alive is another characteristic of mammals which is very naturally repeated in connection with common domestic animals. Children from farms know that calves, colts, and lambs are born alive and often ask if babies are born the same way.

This is a good place to teach the care of pets. If some of the children have horses, calves, or lambs which can be brought to school, a pet show might be held. Each child should show his pet and tell about its care and any tricks it might know.

JACK'S TEETH

Pages: 96–99

Concepts:

Human beings have three kinds of teeth—cutting, tearing, and grinding.

A child's first teeth are baby teeth. These are lost, and permanent ones grow.

To keep teeth healthy, food must not be allowed to stay between them.

Plenty of good food, such as milk, is needed for strong teeth.

Suggested Activities:

Following the study of other mammals' teeth, the children will be more interested in their own. Sometimes a cow's or horse's skull may be found and examined. Compare the teeth with human teeth. The children may look at their own teeth in a mirror or at another child's teeth. They will see that they have some teeth like

a squirrel's—cutting teeth; some like a cow's or horse's—grinding teeth; some like a dog's—tearing teeth.

Since scientists are not yet sure of the causes that make one person have good teeth while another member of the same family may have poor teeth, all we can teach children is that proper food and keeping teeth clean will help them keep the teeth they have.

HIGH IN THE MOUNTAINS

THE WOODCHUCK

Pages: 100–106; 107–110

Concepts:

Timber line is the place in the mountains where trees stop growing.
The trees at timber line are stunted and windblown.
Mountain woodchucks are often seen near timber line.
Woodchucks hibernate in holes in winter.
They live on their stored fat while hibernating.
Some female bears hibernate in winter.
Their cubs are born while they are hibernating.

Suggested Activities:

These are hibernation stories of the woodchuck in a different setting from that presented in SUNSHINE AND RAIN. The woodchuck pictured in these stories is the mountain woodchuck or marmot, sometimes called the "whistler." It is larger and more gray than the prairie woodchuck. It has a black face.

In almost every part of the United States woodchucks are common. Even when you can't see the animals you can find their holes. The teacher should try to locate a woodchuck hole and take the children to see it.

TRIPS WITH COWBOY HAL

Pages: 111–113

Concepts:

A compass helps you to know directions so you won't get lost.
Bones give animals their shapes.

Bones must have food to make them grow.
Milk, eggs, and green vegetables are good bone foods.
When one is growing, he should sit and stand straight so that his bones will grow straight.

Suggested Activities:

Children are much interested in bones they find. Any bones may be examined to try to figure out what animal they are from and how they fit together. We may teach children about their own bones by a comparison with those of other animals. A fish's skeleton is one of the commonest ones that children see. In it they can easily observe the vertebrae. They can see how the vertebrae fit together and then by feeling their own spines make the comparison. Knowing about their own bones makes it easier for the teacher to impress upon them the importance of good posture.

The use of the compass in the first part of the story is to introduce the idea to children. It might be used by the teacher as a problem in itself. "Why does the compass point north and south?" or "Why would a compass help Jack and Cowboy Hal find the right trail?" The children can experiment with a steel knitting needle that has been magnetized. They can suspend it with a strand of silk thread and watch it swing until it points N and S. They may discuss the fact that the earth is a big magnet that attracts just as their magnets do.

THE DOCTOR COMES

Pages: 114–118
Concepts:

Some diseases are contagious, and one who has the disease can give it to others.
To keep other people away from houses where people have some of these diseases, the health officer puts up quarantine signs.
Germs cause these contagious diseases.

Suggested Activities:

This story attempts to teach the word "quarantine." It also is intended to show the reasons for staying away from people who

have contagious diseases. The teacher should try to teach children how to prevent disease. A good time to introduce it is when someone has measles or some other contagious disease.

Common colds are more difficult to control than any of the contagious diseases. This is probably due to the fact that people do not regard them seriously. But colds are contributory to many more serious diseases and worth much more consideration than is ordinarily given them. Children should be taught every precaution for preventing colds. A child with a cold should be kept in bed and treated with as much care as if he had any other disease. The use of paper handkerchiefs that may be burned, covering nose and mouth with handkerchief when sneezing or coughing, and staying away from well people, all help prevent the spread of colds.

Many primary schoolrooms have a supply of paper handkerchiefs that the children use, even when they don't have colds. It is an excellent provision.

Children are much more impressed with the importance of preventing the spread of disease if they have raised some "germ" gardens on agar or gelatin cultures. The preparation of gelatin cultures is described in the Manual for WINTER COMES AND GOES, pages 83 and 84.

READING THERMOMETERS

ANOTHER THERMOMETER

Pages: 119; 120–121

Concepts:

We can tell the temperature of the air by a thermometer.
The numbers on the thermometer tell us the exact temperature.
The doctor and nurse use another kind of thermometer to tell how hot your body is.
A well person has a temperature a little above 98.
If a person's temperature is much above 98, he has a fever.

Suggested Activities:

In the first books of THE HOW AND WHY SCIENCE SERIES, the children learned the purpose of the thermometers. They learned that heat makes the line in the thermometer go up and cold makes

it go down. Now they learn to read the thermometer. "Degree" is still too difficult a concept, but they can read numbers.

To help make the concept more meaningful, the teacher may perform a simple experiment. Fill a glass flask or bottle with water that has been colored with red ink. Put a stopper with a glass tube in it into the neck of the jar. Mark where the water comes in the tube by putting a rubber band around the tube. Stand the flask in hot water. Note the rise in the tube. The children should draw the conclusion that water expands when it is heated. They may discuss the possibility of using water in a thermometer. They can see that it takes much heat to make the water rise far enough to be measured. The question will arise as to what is used in thermometers. They should look at some, and the teacher may tell them that those with red liquid have colored alcohol; those with silver, mercury. Before drawing any conclusions about the liquid in the thermometers, another experiment should be used. Place a thermometer in cold water. Children should feel the water; note the place where the line goes; then gradually heat the water and watch the liquid in the thermometer rise. A bath thermometer is a good one to use for this experiment.

In the story of the clinical thermometer, the children learn that their bodies have temperature just as the air has; that their temperature remains constant if they are well. Show them a clinical thermometer. The school nurse may demonstrate its use.

AIR

Pages: 122–130

Concepts:

Air is real and fills space.
Two things can't occupy the same place at the same time.
Air helps hold up gliders and other aircraft.
The larger the surface of a floating body, the longer the air will hold it up.
Air has pressure. It presses in all directions.
Air pressure may be used to do work.

Suggested Activities:

This chapter develops further the concepts about air started in

the first and second grades. If the children haven't gained the concepts, the teacher will need to begin with very simple experiments to develop such ideas as:

Air exists.

Air is all around us.

We can't see air.

We can feel air when it moves.

(See the Manual for THROUGH THE YEAR for suggested activities.)

The experiments in this present book develop the concept that air is everywhere. Two things cannot occupy the same space, so air must come out of a bottle before water can go in. Other simple ways of showing this would be to try to fill a small-necked bottle with water. Air has to come out. After the bottle is filled, try to pour the water out. This will also show that air has pressure.

The experiments given here are easily done. Another simple one that shows the same thing is trying to pour milk from a can that has only one hole punched in it.

A spectacular experiment may be performed with a milk bottle and an egg. Peel a hard-boiled egg. Put it in the opening of a milk bottle to show that it won't go through. Remove the egg, burn a piece of paper in the bottle, then put the egg quickly in the top of the bottle. It will go into the bottle with a pop. The problem as to what made the egg go into the bottle requires an explanation of the expansion of air when it is heated as well as the pressure of the air on the outside. This experiment may stimulate reading "Why Susan's Balloon Burst." Ideally, the experiments should be done first to help answer a question; then the reading should be done.

The experiment on page 126 will work only if the milk bottles are full and capped with air-tight metal caps. An experiment to demonstrate may be done if one has a bottle and rubber cork to fit. Put a glass drinking tube through the rubber cork, fill the bottle with milk, push the cork into the bottle and let a child try to drink the milk. If any air leaks into the bottle, the experiment won't work.

It is interesting to try the experiment on page 127 in a different way, also. After doing it with paper or a card, some child may say that water won't run through the paper. The teacher may say

"Will water run through cloth? Let's try it with a piece of cloth." By holding the cloth tightly around the glass and inverting the glass quickly, the water may be kept in the glass. Then it may be tipped back and forth to show that as a bubble of air enters, a drop of water comes out. This experiment may be done even with cheesecloth.

A simple experiment to show air pressure is to use a rubber sink stopper. Wet it and press it down on a smooth, heavy object. You can pick up the object with the stopper. There are many simple gadgets that use this device, such as things that fasten to automobile windshields with suction discs.

WHY SUSAN'S BALLOON BURST

Pages: 131–135

Concepts:

Air expands when it is heated.
Air contracts when it is cooled.

Suggested Activities:

The teacher should avoid the idea that air rises when it is heated. Air moves in every direction as it expands, but it cannot move downward very far because of the earth.

There are many simple experiments that will help fix the concept that air expands when it is heated and contracts when it is cooled. The experiments suggested in the book are simple if one has a thin glass bottle. If the glass is thick, heat from the hands may not be enough to demonstrate the principle. In that case, stand the bottle in a pan of water and heat it.

Another way to show this is to fasten a toy balloon over the top of a cold milk bottle and heat it in a pan of water. The expanding air will blow up the balloon. Then remove the balloon from the hot water and watch it as it cools. To make the air colder, put snow or ice around the bottle. The balloon may be pushed into the bottle by the air above the bottle.

Discuss common experiences illustrating this principle, such as bubbles coming out of a milk bottle which has been inverted in the dish pan, or the "popping" of vaco-seal lids on fruit jars as the air between the lid and the fruit cools.

WHAT MAKES SOUND?

Pages: 136–139

Concepts:

Some toys make sounds.
All sounds are caused by vibrations.
Vibrations are rapid movements.
When an object vibrates, it makes the air around it vibrate.
The vibrations of the air come to your ear and you hear the sound.

Suggested Activities:

The most natural way to introduce a unit on sound is through toys. The principle may be demonstrated by using rubber bands stretched tightly, by striking tumblers having different amounts of water in them, and by striking pieces of metal. In all cases the children can see the vibrations and should notice the difference in pitch and quality. The teacher needn't use the terms "pitch" and "quality" to make the children aware that there is a difference.

Some other simple activities are moving a yardstick or thin ruler at different rates of speed to hear the swishing noise; doing the same thing with a piece of paper; blowing against a piece of paper to feel the vibrations on the lips; feeling the throat vibrate as one speaks or sings; making and blowing whistles made of willow stems, elderberry stems, dandelion stems, or other hollow stems.

Many children have made simple musical instruments such as a marimba of blocks of wood of different lengths. If not, they may experiment to see how the size of the piece affects the sound.

By taking apart a rattle or horn or other sound-making toy, they can see the parts that cause the vibrations.

THE WINTER LUNCH COUNTER

Pages: 140–143

Concepts:

Not all birds migrate in autumn.
Some birds come from the north to spend the winter.
We can help feed birds in winter.

Suggested Activities:

This story is a review of the birds the children have seen. The sparrow shown is a tree sparrow, a common winter resident in the northern part of the United States. Tree sparrows flock with juncoes, coming south from Canada in autumn and returning to their nesting grounds in the spring. A few may remain, but they are not common. There are several species of juncoes but all have the characteristic white breast and outer tail feathers.

Tree sparrows and song sparrows look much alike and one sometimes finds a song sparrow at the feeding shelf. Most song sparrows migrate.

The goldfinch in winter is rarely as bright looking as the one in the picture. They are easily mistaken for sparrows, so dull is their grayish winter plumage. This dull plumage is the result of an autumn molt. At that time mottled yellow and gray birds are often seen.

Several species of nuthatches, chickadees, and jays are found wintering in different parts of the United States.

Fat is needed by birds during cold weather but it doesn't have to be suet. Any scraps of fat meat or bones with bits of meat and fat clinging to them will be attacked by birds. Waste fat may be melted and poured into cans or other containers and allowed to cool. Half a coconut shell so filled and hung from a tree branch or bracket will prove a source of pleasure for a long time. As many as nine nuthatches have sat on such a feeder at once. Holes may be bored in a log and filled with melted fat. Seeds and nuts of various kinds, gathered by the children in autumn, may be cracked and added to the fat.

The children should have a feeding shelf of their own, if it is no more than a window ledge. Directions for bird feeding and the making of feeding shelves are given elsewhere in this Manual and in the story on pages 151–155 of The Seasons Pass.

A GROUND BIRD

Pages: 144–145

Concepts:

Some birds live on the ground and get their food as chickens do.

The quail is one of these ground birds.
Quail can't fly very far, so they don't migrate.

Suggested Activities:

This story with its accompanying illustration introduces a new type of feeding station and a new bird, the quail. It carries on the idea of interpreting winter activities of animals by following their tracks.

Quail belong to the same general group of birds as chickens and pheasants. Their heavy legs and feet fit them for scratching on the ground for their food. Their beaks are shaped to pick up small seeds, hard-bodied insects, and other things they find in the dirt. Their short rounded wings will carry them out of danger but not on long flights.

In bringing out the characteristics of this group of birds, the teacher may ask such questions as, "Why is the quail here in winter? What other birds get their food as the quail does? How are the bodies of quail, chickens, and turkeys alike? How are they different from robins?"

These birds are used for food because they have so much muscle on their legs. Also, since they do not fly much, their bodies are heavy.

The type of shelter described here must be guarded from cats. Children should be taught that when they feed any kind of animal and protect it, it loses some of its natural fears and may be easily caught by a cat or other enemy or shot by a man. If we protect wild life by feeding birds or other animals, we must also protect the animals by restraining their enemies.

BEAKS AND FEET

Pages: 146–150

Concepts:

The beak of a bird is used to get its food.
The shape of its beak makes it possible for a bird to get the kind of food it eats.
Birds also use their feet to help them get food.
One can tell by its beak the kind of food a bird eats.

Suggested Activities:

This story summarizes concepts mentioned in various stories throughout the series—that of structural adaptations. The purpose is to give practice in problem solving with interesting material to which the children can add information gained through observation. The understandings acquired will help them to identify the birds they see and want to know the names of.

The children should examine beaks and feet of any live birds that are available. Chickens, canaries, pigeons, and ducks are good ones to start with. The teacher should be careful not to give the children the idea that the birds grew modifications of beaks and feet to help them live the lives they lead—rather that because certain ones had those modifications they have survived. Thus, those birds with beaks that can get insects easily, survived because they were able to eat what their less fortunate brothers could not.

The teacher can find much information in the references given. Lacking live material for the children to study before reading the story, pictures that show detail of feet and beaks should be used. After reading and discussion, puzzle pictures might be given showing feet and beaks of different types of birds. The children should try to figure out what type of food the birds eat.

The pictures at the bottom of page 150 are the feet of: duck—swimming; chicken—scratching; song bird—perching.

HOW TO MAKE FEEDING SHELVES

Pages: 151–155

Concepts:

One may make feeding shelves, even in the city.
English sparrows help other birds find a feeding shelf.
A swinging shelf will frighten English sparrows.

Suggested Activities:

In the earlier books of the series, feeding of winter birds was suggested in a simple way. This story tries to show different types of feeding shelves that might be made by eight-year-old children. It also introduces the idea that children living in cities as well as children in small towns or the country may feed winter birds.

The story itself is to direct activity on the part of the children. A chapter on winter feeding of birds in an earlier part of this Manual will help the teacher further. The children need not be disappointed if birds don't come right away. It takes a little time for birds to know where food is. Once they discover the shelf they will return year after year. English sparrows may be the first to come, but other birds will follow. After they start coming, swinging or movable shelves may be put up to keep the sparrows away.

Some of the simpler ways to feed birds are to hang dry doughnuts from strings; to tie peanuts to a string and fasten across a window; to hang a soap shaker full of fat from a nail; to scatter sweepings from a flour mill on the ground under a tree.

The joy of being able to watch birds a few feet away through a window will repay the children for their trouble. The teacher should have good bird pictures available for correct identification of any birds that come.

DAY AND NIGHT

Pages: 156–160

Concepts:

Shadows help us learn about the movement of the earth.

The earth turns completely around in a day and a night.

The side of the earth toward the sun is having day, the other side night.

The earth is a heavenly body.

The earth is not hot like the sun so it has no light of its own. It gets light from the sun.

Suggested Activities:

This story involves activity. It should be read in response to a question similar to the one asked by Nancy. If such a question doesn't arise naturally, the teacher should motivate it in some way. She may do this by calling attention to moving shadows or to the changing position of the sun as the seasons advance.

In the first books of the series the children discussed the sun and learned that we get heat and light from the sun; that the sun makes day. But they were too young to imagine the earth as a globe

rotating in space. It is pretty difficult for adults to project themselves into space enough to see the earth as a ball. The teacher should try to enlarge the children's concepts by starting with the place they live and moving out from it.

In their imagination they can go higher and higher, seeing farther and farther, until the earth appears rounded. A globe should not be introduced until this concept has been taught.

If children are taught from the beginning that we are moving in relation to the sun, rather than that it is moving across the sky, they will always sense the motion of the earth. Of course, the sun is moving through space, but since the whole solar system and the galaxy of which the sun is one star is moving with it, we are not conscious of it. Third-grade children are too young to understand this, so we teach them first merely the movements of the earth and moon.

If the children who are using THE SEASONS PASS have not read the first books of the series, the teacher should discuss with them the ways in which the sun makes life possible on the earth. She should let them carry out some of the activities suggested in earlier Manuals in connection with the sun.

Sometimes children ask the question, "Why are the children in China having night when we are having day?" Or they may hear from a radio station farther east that it is dark while it is light where they are. Or they may hear the announcer at the Rose Bowl game giving plays long after it is dark where they themselves are. These are natural approaches to the problem of what makes night and day.

If the children don't ask about it, the teacher may introduce the problem by saying something like this, "I heard about a little boy who lived out west who used to watch the sun go down behind the mountains. One night he said to his mother, 'It's fun to see the mountains push up in front of the sun.' What do you suppose he meant?"

Let the children give their ideas, then bring out the light and ask if they can demonstrate what the little boy meant. At the point in their discussion when reading will help, they may open their books to page 156 and read what Bob, Jane, Nancy, and Jimmy did. They should read to the bottom of page 158, then do the

same experiment. That may be enough activity for one period and they may go on to the next experiment another time. In the meantime, if the children are interested, they will observe many things about the sun to report to the class. The measure of our success as teachers is not in what children can repeat at the end of the period but in how much they carry with them into their life outside of school.

THE MOON

Pages: 161–165

Concepts:

Months are determined in part by the moon.

The moon moves around the earth.

The moon shines because the sun shines on it.

The moon seems to change its shape because it moves around the earth. We see the whole lighted side one night. The next night we see less, and the next less, until the lighted side is away from us. That night we don't see the moon. Then we start seeing it again the next night and see more each night until it is full again.

Suggested Activities:

This story follows the one on night and day and may be used with it. Questions about the moon may come up before the ones on night and day.

The best time to introduce moon study is when the moon is visible in the daytime. When it is in the first or last quarters it is in a position that makes it easy for the children to see how it is lighted by the sun.

When the moon is in the first quarter, it rises at noon and sets at midnight, for it has traveled one-fourth of its orbit around the earth. The teacher should be sure that she understands this herself before she teaches it. By using a globe, small ball, and a light she can figure it out.

When the moon is in the first quarter it is about overhead at sunset. So if the children go out of doors in the afternoon they can see the moon somewhere in the eastern sky and the sun in the

western sky at about a 90° arc. They can often see the outline of the whole moon, although only the half of the surface toward the earth appears lighted. By observing it at intervals during the afternoon and from day to day as it grows toward a full moon, they begin to get a feeling for the relationship of moon, sun, and earth. Long after they have read the story in the book and performed the experiments, the children will be observing the moon. When they tell about these observations, let them draw on the blackboard what they have seen and explain why the moon looked that way. Even let them get out the globe, ball, and light to help them explain if they wish. It is a good way to review.

For the teacher's information, the moon is about one-fourth the diameter of the earth. It takes about twenty-eight days for it to revolve around the earth. It rotates on its axis once as it revolves. That is why we always see the same side. If you walk around a table keeping your face toward the table it is like the moon revolving around the earth.

The moon's orbit is something like a spiral, hence its changing position in the sky. The plane of its orbit changes from month to month. It moves up and down in relation to the earth's orbit. Of course this is too difficult for children, but the teacher needs to understand it.

The moon is about 240,000 miles from the earth. In volume it is about $\frac{1}{59}$ of the earth.

The sun is about 864,000 miles in diameter or about 109 times the diameter of the earth. The sun is 93,000,000 miles from the earth.

The picture on page 165 is to give the children an idea of relative sizes, not distances. It will be helpful in teaching about the sun and moon if the children look at the pictures on pages 114 and 115 of WINTER COMES AND GOES. Also see the suggested activities in that Manual.

JIMMY'S STAR PICTURES

Pages: 166–167

Concepts:

Near the star group called Orion is the Dog Star.

Near the North Star is a group of stars called Cassiopeia.

Suggested Activities:

Cassiopeia is the new constellation added to the ones the children may have learned about in the first books of the series. It is one of the circumpolar constellations, always visible in the northern sky in the northern hemisphere.

Because the children reading this book may not have read the first ones of the series, Jimmy reviews them in his star maps. The teacher should look up the Manual suggestions for the other books and start star study with the Dippers. The Big Dipper is easily found. The Little Dipper is more difficult to find, but once located the two make a starting point for finding the other constellations. Cassiopeia is the W or M above the Little Dipper on page 167. This is the northern sky. The teacher may do as much with star myths as she likes. Since the myths are a basis for the names, they help explain star groups or constellations.

The constellations on page 166 are those in the southern sky in winter. The one in the middle of the page is Orion. The three center stars at an angle make his belt. The bright star below and to the right is Rigel, Orion's knee or foot, depending on the version of the story. The bright star above to the left is Betelgeuse, the red star in his shoulder. Betelgeuse is the next-to-the-largest star we see in the sky. It is so large that it would cover our sun and the orbit of our earth.

To the right and up from the constellation of Orion is Taurus, the Bull. The bright red star in the triangle of his head is Aldebaran. It is supposed to be the eye. In the extreme top right is a tiny cluster of the Pleiades or Seven Sisters.

Below Orion to the left is the bright star Sirius, in the constellation of the Big Dog. Sirius is the nearest star seen in the United States and is the most brilliant one in the winter sky. Children often ask about it because it seems to change color. In the middle of winter Orion rises a little south of east and is soon followed by Sirius.

Children become very excited about stars and with a little help will soon know most of the common constellations. As a matter of fact, children seem to be able to recognize and locate constellations more easily than do many adults.

JACK'S CLOTHING

Pages: 168–173

Concepts:

Our bodies make heat.
Clothing keeps the heat in our bodies.
The hair on horses' bodies keeps their heat in.
The wool on sheep keeps their heat in.
Woolen clothing is warmer than cotton or silk.
Cotton comes from a plant.
Silk is made by a caterpillar.
In winter our clothing keeps our body heat in.
In summer our clothing lets the heat out. Sometimes people wear woolen clothing to keep outside heat from their bodies.

Suggested Activities:

This story is to teach children why we wear warmer clothing in winter than summer. Usually they think of the clothing instead of their bodies as the source of heat.

In connection with this story the children should experiment with different fabrics to discover which ones conduct heat most readily. To do this, make pads of about four thicknesses of wool, silk, cotton, and linen cloth. In turn lay each on a hot plate or radiator and let the children feel to discover through which they feel the heat most quickly. Discuss what would happen to the heat in the body if that fabric were worn.

If possible the teacher should have raw cotton, wool, and silk for the children to examine. This is a good story to integrate with industrial arts.

JOYCE'S NEW PLANT

Pages: 174–177

Concepts:

Some plants are grown from slips.
A slip is part of a stem having a bud on it.
If a slip is put into water, roots will grow from the cut end. Then it may be planted to produce a new plant.
New plants will grow from seeds, bulbs, and slips.

Suggested Activities:

In the first books the children learned that new plants come from seeds and bulbs. This story introduces the idea that new plants may be produced from slips.

The children should slip different kinds of plants and start them in sand or water. Coleus, begonias, geraniums, wandering Jew, and many other house plants may be slipped successfully. Mothers will gladly furnish pieces from their house plants for the experiments.

In slipping plants like geraniums be sure to have a good bud and enough stem to put into the soil. Begonias will grow from a cut leaf with the cut edge put in damp sand. African violets will also grow from a leaf. The plant may be started in water and planted when the first little new leaves are growing.

The children should gain from this story the concepts that plants may be propagated in many ways; that through experimenting with plants men have developed better ones and new varieties.

Children should realize that seeds are the parts of the plant set aside for reproduction. These other methods are asexual propagation. The new plant growing from a bulb, slip, leaf, or graft will be like the parent plant while those growing from seeds will have characteristics from two parents. Seeds grow in the reproductive organ of a plant, the flower, and result from the union of egg cell and sperm.

To hasten the growth of roots on a slip, a little vitamin B_1 may be put into the water. If a control is set up without the B_1 the children will be able to see how much faster the roots develop when stimulated by the vitamins. Plant vitamin B_1 may be bought in tablet form at 10¢ stores, seed stores, and drug stores. One tablet will supply enough solution for many experiments.

JIMMY'S PUPPY

MY CAT

Pages: 178–185; 186

Concepts:

Puppies are nice pets to have.

They should be well cared for.

A healthy dog does not have a hot, dry nose.
Cats make good pets, also.
Both cats and dogs have tearing teeth.
Cats can pull their claws up between their toes and walk quietly.
Cats see at night better than dogs do.
Dogs have a keen sense of smell.
Cats should not be allowed to roam at night, for they catch little birds.

Suggested Activities:

All children like pets but many of them do not realize the importance of caring for their pets properly. Often they leave the care to their parents.

The approach to this story might be a new pet some child has acquired. The children should discuss their ideas of how the pet should be cared for.

If many children have pets, they may have a pet show and each child tell about the care of his pet. Through discussion bring out the importance of consistency in the training of a pet. Whether or not a puppy grows into a well behaved, healthy dog depends upon its first year. Few children have any idea of how to teach a dog to obey a quiet command or how to teach it tricks. The teacher may find this information in a pet book or ask someone who raises and trains dogs to answer the children's questions.

While cats do not seem to respond so intelligently as dogs, cat lovers say that they too can be taught. Other pets may be trained in varying degrees, depending on their brain development.

No child should own a pet unless he is willing to assume as much of the responsibility as his age will warrant. Even a two-year-old can help in the care of a puppy.

The story also brings out the characteristics of an order of mammals, the *Carnivora* or flesh-eating group. If the children have seen circus animals or been to a zoo, they may recall the wild members of the dog and cat families. The sharp meat-eating teeth are the main characteristic of the whole group.

In addition to learning how to care for their pets, the children should learn that cats catch birds when allowed to roam at night.

The only way to be sure they don't kill birds is to keep them shut up at night and see that they are well fed.

DICK'S COW

Pages: 187–195

Concepts:

The people in the United States use cows' milk.
Cows must be kept in clean barns.
They must be clean when they are milked.
The milker must be clean and must use a clean pail.
Dirt has germs in it. Boiling bottles kills any germs that may be in the bottles.
Clean milk makes a smooth, good-smelling curd.
Dirty milk sours with gas bubbles in it and has an unpleasant odor.
Butter, cheese, and ice cream are made from milk.
Milk is good bone food.
The whole part of milk makes a curd and the watery part is the whey.

Suggested Activities:

This is a combination unit including both science and health concepts. The first part of the story is intended to teach about milk as a food and how to care for it properly.

If possible the children should visit a dairy and see how milk is obtained. They should do the experiments suggested in the story. Clean milk sours with a smooth solid curd that goes to the bottom of the bottle. When bubbles form in the curd they show the presence of gas. This gas is usually produced by a type of bacteria found in the intestinal wastes of animals. Although the milk may not contain disease-producing organisms, the presence of these gas-forming bacteria indicates contamination of some sort. Of course the absence of these bacteria doesn't prove the milk to be free from other harmful bacteria, but they are not so likely to be present.

An easy way to make butter in a schoolroom is to shake sour cream in a fruit jar. Most teachers will know how to handle the activities suggested by these stories.

The importance of milk in the diet may be made more emphatic by letting the children make a bulletin board of meals containing milk. The National Dairy Council puts out a great deal of material which may be used, also.

BOB GOES TO THE STORE

Pages: 196–199

Concepts:

All foods should be kept clean.
Fruit should be washed or peeled before it is eaten.
Meat is needed in the diet.
Fruit and vegetables should be eaten each day.
A growing child needs a quart of milk each day.

Suggested Activities:

If possible, take the children to a grocery or market and let them suggest what they would choose for various meals. The foods which should be included in an eight-year-old child's daily diet are:

Milk—1 quart
Eggs—1
Meat—At least one serving
Citrus fruit—One serving
Butter
Whole grain cereal and enriched bread
Two highly colored vegetables

There are two reasons for washing fruit or peeling it. One is that there may be disease organisms on it; the other is that it may have been sprayed and have some poison on the skin.

PICTURES IN ROCKS
ROCKS HAVE NAMES

Pages: 200–204; 205–208

Concepts:

Some rocks have fossils in them.
Fossils are prints or remains of ancient life.

Limestone is one kind of rock which has fossils in it. Not all limestone contains fossils.

One may find fossils in many places.

Fossils tell us something about the history of the earth.

A special kind of acid is used to test limestone. It fizzes when it is put on limestone.

Some other kinds of rocks are sandstones.

The sand in sandstone will scratch glass.

Shale is a kind of rock made of clay.

Suggested Activities:

This unit has grown out of the demands of children for more knowledge about rocks. Few books on their reading level answer their questions.

Children have a natural interest in rocks. In places where there are many rocks, the teacher's job is merely to help the children find the answers to their questions. In a region where they aren't so numerous, she may have to introduce the subject in a way similar to Miss Parker's introduction.

The fossils in the rock shown on pages 200 and 201 are trilobites and brachiopods, but of course we don't use these words with children. The important thing for them to get is that there are fossils in rocks that were made many years ago. This concept contributes to the development of the larger concept that the earth is very old. The children should also get the concept that though these fossils are similar to animals that live today, they disappeared from the earth long ago. An exciting way to introduce such a unit is for the teacher to have a piece of limestone that she is pretty sure has fossils in it. Then showing it to the children she may say, "I think there is something left by an animal in this rock. No person has ever seen it. If we break it open we will be the first people to see it." The children may break it and have the fun of finding some fossil. Most children will be as interested as the children in the story.

The fossils on page 204 are:

Bob's fossil—Brachiopod. Though it looks like a clam, it belongs to a different group.

Nancy's fossil—Cup Coral.

Susan's fossil—Crinoid. Bits of crinoids look like pieces of a fish backbone. They are sometimes called "Indian beads." Crinoids are closely related to starfish.

Jimmy's fossil—Brachiopod—a kind sometimes called "angel wings."

These fossils are typical of those found in gravel pits in glacial deposits in northern United States. In other parts of the United States, other types of fossils may be found. The teacher may easily learn what to look for by consulting an historical geology such as *Life of Long Ago* (see bibliography).

Since fossils are often found in limestone, the children may want to learn the test for limestone. It is called the acid test in the story but the teacher will need to know what acid to use for a conclusive test. It is dilute HCl or hydrochloric acid. HCl is commercially known as muriatic acid and may be purchased at any drug store or plumbing shop.

For the limestone test, dilute *concentrated* HCl in the proportions of 1 part HCl to 4 parts water. Pour the acid into the water. If a drop of the cold dilute acid makes bubbles or effervesces when placed on a rock, we call the rock limestone. There are many kinds of limestone, but this test is sufficient for a child of this age. The teacher must be careful not to call the rock *lime.* It is actually calcium carbonate, sometimes called lime carbonate. Lime is a different compound.

Sometimes sandstone is cemented together with calcium carbonate. In that case it will of course react to the acid. The children can tell if it is sandstone by the way it feels. Sandstone scratches glass. Fossils are sometimes found in sandstone and shale.

The purpose of these stories will be accomplished if children have an awakened interest in rocks and a widened concept of the earth on which they live. The teacher will find help in identifying rocks in some of the references. The ones mentioned in the story are easily recognized.

There is a fine opportunity to develop scientific attitudes and methods of problem solving in rock study. Before naming any rock or mineral, all the tests should be applied to be sure of what

it is. If there is any doubt, better leave it unnamed. A scientist often spends years of study before drawing a conclusion. The scientific attitude that one should not draw conclusions with insufficient evidence may be started here.

HOW SOIL IS MADE

WE NEED SOIL

Pages: 209–211; 212–220

Concepts:

Soil comes from broken-up rock.
Freezing and thawing helps break up rocks.
Heating and cooling helps break up rocks.
Plants grow into rocks and make cracks.
Rocks are made of minerals.
These minerals become part of the soil.
Plants use minerals to grow.
Some minerals are hard; some are soft; some are soluble; some are not soluble.
Decaying plants make a soil called humus.
Sand and clay come from rocks.
A mixture of soils is called loam.
Loam is better soil for plants than sand or clay alone.

Suggested Activities:

Following the study of rocks, questions on the formation of soils are natural. The earth's crust is continually being broken down into soil and redeposited to make rock. These stories attempt to teach some of the agencies of decomposition and disintegration.

The children may repeat their experiments with freezing water in jars and cans. If they can find a rock with a hole or deep scratch in it, they can pour water into it and let it freeze. They should take trips to find examples of rocks that are weathering. They can pound up different kinds of rock to learn that they make soil. They may find rocks that are being cracked by tree roots. They should find evidence of earthworms' work and discuss what earthworms do for the soil. They should examine humus to find bits of roots, stems, and leaves.

The following chart may help the teacher understand the rock-soil-rock cycle.

Igneous Rocks or Fire Rocks (Rocks that have been molten)	*Agencies of Decomposition and Disintegration*	*Soils*	*Sedimentary* (Rocks formed in lakes and seas by sediments)	*Metamorphic* (Rocks formed by heat and pressure from the other rocks)
Granite—Common minerals				
Mica	Wind	Gravel	Conglomerate	
Feldspar	Water	Clay	Shale	Slate or Schist
Quartz	Sun	Sand	Sandstone	Quartzite
Diorite	Carbonic acid			
Basalt	Animals			
Felsite and others	Plants			
	Decay of plants and animals	Humus Marl	Soft coal Limestone	Hard coal Marble

The children could make a chart similar to this on a piece of beaver board, mounting the rocks and soils on the board.

To understand how much we need soil, the children should do the experiments suggested in the story. They may perform other experiments to discover which soils hold the most water and through which ones water travels the most rapidly.

They should examine clay, sand, and humus, noting the color and texture of each, and how it feels when wet. They may nearly fill three tin cans with holes punched in the bottom, each with a different soil. They should pour the same amount of water into each can at the same time and observe through which one the water drips first. They may mix sand, clay, and humus to make loam. Technically, loam consists of clay and sand, but to the farmer, it is garden soil—clay, sand, and humus.

The reason for having two pots of each soil is for a check. It would be much better if there were a number of pots. One danger we must avoid is drawing conclusions from insufficient evidence. The paper cups one can get at a 10¢ store will work for these experiments. So will tin cans. It is a good plan to have many going at once.

Some of the results may be puzzling. For example, seeds will

sprout quickly in sand if they have enough water. In fact, for several weeks they may be ahead of the plants growing in loam. Also, different pots with the same soil may show varying results. Teachers may lead children to observe and discuss these differences with questions like, "I watched Jane and Bob planting their seeds. I thought that they did it the same way but look at their plants. Why do you think Jane's is so much taller than Bob's?" Many factors may enter into the differences, such as depth of planting, too much or too little water, amount of light or heat, and so on. Granted that all of these were the same, the conclusion must be that the seeds differed. If each child plants two seeds, he knows that there is a difference. This concept contributes to the principle of variation.

HOW SOIL IS CARRIED

Pages: 221–223

Concepts:

Rivers are made by water flowing from higher places to lower places.

Small rivulets, made by the rain flowing downhill, make larger and larger streams.

The water running downhill carries soil from the higher places to the lower ones.

Swiftly-moving water carries more soil than when it spreads out and slows down.

Soil is also carried by wind.

Suggested Activities:

The melting snows and spring rains offer a fine opportunity to teach how rivers are made. The children should experience the same things the children in the story do. If there is a river near by, or a brook, go to it and see how the valley has been made. Pictures of river valleys are useful here to widen the children's immediate experience.

Following a heavy rain, go outside and watch the water pouring down terraces, banks along the road, and other slopes. Notice how

it deposits the large particles first, as it spreads or slows down. Notice, too, that where there is grass or other vegetation, there are no gulleys, but where a path has been made across a lawn, or a road made across a field, deep gulleys are formed. Discuss the harm done by such erosion and ways that the children can help stop it.

Third-graders are old enough to begin to take an interest in soil conservation. In cities they can plant grass seed on the bare places made by people cutting across lawns. They can put signs at each end of the path to tell people what they are doing. Then they should use the walks and ask other children to do likewise.

In rural districts, children may plant grass or shrubs on the school grounds to prevent washing. They can divert small streams that are making gullies by means of proper ditches or drainpipes. More important than any other phase of such an activity will be the interest and attitudes that the activity will arouse.

JIMMY LEARNS ABOUT HIS SKIN

Pages: 224–225

Concepts:

When a person is hot, he perspires.
Perspiration comes out of small openings in the skin.
Perspiring helps cool the body.
Bathing helps keep the pores open.

Suggested Activities:

This story is self-explanatory. It should help the children to realize the importance of bathing to keep the skin clean. The teacher should point out the necessity of drinking plenty of water to replace that lost in perspiration. The children should discuss the times that they perspire most. In dry climates perspiration isn't so noticeable as in damp climates. Also, on clear dry days it evaporates more quickly than when the air is very humid and warm.

To demonstrate the value of perspiration as a cooling mechanism, ask the children to blow on their hands. Then wet one hand and blow again. They will feel the difference at once.

THE CARDINAL'S FAMILY

Pages: 226–234

Concepts:

Cardinals are red birds with thick, seed-eating beaks. They are permanent residents where found.

The male cardinal chooses his territory in spring and announces it by singing.

Male cardinals will fight for their territories.

Female cardinals are not so brightly colored as the males.

They build their nests in bushes and trees.

The female builds the nest while the male stays near to guard. He often sings.

Three or four eggs are laid in the nest.

Newly-hatched birds are called fledglings.

Cardinal fledglings are naked and helpless.

Both parents feed the young on insects, berries, and seeds.

When they grow feathers, the young birds look like their mother.

The dull color of the mother and her young helps protect them.

Suggested Activities:

In the first books of the series the children learned about the life cycles of the robin and the oriole. Here is the cycle of a bird belonging to another family, the grosbeaks. In the North, the cardinal's close relative, the rose-breasted grosbeak, is found. In the West we find the black-headed grosbeaks.

The cardinal is a beautiful bird that is a native of the southern United States. It has gradually moved northward until it is found even north of the Ohio River as a permanent resident. It is welcomed not alone because of its color and song but because it destroys many harmful insects.

If possible, children should watch some member of this family and check its activities with the ones mentioned in the story. So much is yet to be learned about the habits of birds that any group of children may observe something new. Suggestions on how to conduct field trips are given elsewhere in this Manual. Care should be taken that children observe accurately and not jump to incorrect conclusions.

Nothing is more exciting than to watch the courting, nest-building, and rearing of young birds. Permanent interests or hobbies often grow out of such activities. A desire for conservation of bird life is easily started by such a study. Many worth-while attitudes and habits are developed.

The new concept taught in this story about the cardinals is that the male cardinal chooses a territory and defends that territory against other male birds. Most of our song birds do the same thing, as do many other birds.

If there are cardinals in the locality, the teacher should try to find the territory of a male bird by listening for his song. By observing for several days she can tell if the bird comes back to the same tree to sing. After seeing the bird in the same place for several days she can have the children begin to observe it.

Cardinals are rather shy and easily disturbed in their nesting, so any nests located should be observed with caution. The way Dick watched was ideal, for it in no way disturbed the birds.

Young cardinals are the dull olive or brown of the mother, the males getting their bright plumage after the autumn molt.

The rose-breasted, black-headed, and blue grosbeaks have very similar habits. They eat many beetles, both larvae and adults. Where potatoes are grown, the grosbeaks help destroy potato beetles. Their beaks are fitted for cracking hard seeds, such as sunflower seeds. These will attract them to feeding shelves in early spring.

Evening grosbeaks, bright yellow and black relatives, are especially fond of frozen buds and apple seeds. They are often seen in winter in the western states, feeding on shriveled, frozen apples that are clinging to the trees. Cardinals do the same thing.

Pine grosbeaks and crossbills are other western members of this family which some of the children who are reading this book may see. They should compare the birds that they see with the cardinal. The teacher may start a discussion with a question something like this: "Which bird that we have read about does the black-headed grosbeak look most nearly like? Why? Is it the same color as the cardinal? Does it have a crest? In what ways are they alike? I wonder if they have the same habits as cardinals. How can we find out? The first person who is rea-

sonably sure he has located a grosbeak's territory may lead us to it." This type of motivation is sure to arouse interest and usually brings results. Children have much better luck locating nests and sites than most adults. Of course, before starting such a hunt, children must have developed the right attitudes toward birds so that they will observe but not disturb nests.

The correct word for "baby" birds, *fledglings*, is introduced here.

HOUSE FOR RENT

Pages: 235–241

Concepts:

Some birds will make nests in bird houses.

Bluebirds belong to the same family as robins.

They build their nests in holes, so will go into a bird house.

Bluebirds lay four blue eggs.

Cats often climb trees and eat birds.

We can protect the birds by putting a tin collar around the tree or pole below the nest.

Both bluebird parents feed the fledglings.

Bluebirds eat many insects.

Suggested Activities:

The bluebird story not only adds another bird cycle but introduces the concept of protecting a bird house from cats.

Bluebirds are members of the same family as robins, the thrush family. Young robins and bluebirds have speckled breasts like other members of the thrush family.

All the bird stories in this book are for the purpose of widening the children's interest in birds and answering their questions about birds.

Many types of units may be set up that concern birds. The one suggested is how some common birds have their young. All through the year the children have been learning more about adaptations of birds and bird protection. This study could be culminated in the spring with the unit on how birds have their young.

The bluebird in the story is the eastern bluebird but its habits are very similar to those of the western and mountain bluebirds. One of the interesting facts about these birds is that their feathers are not actually blue. If a feather is found on the ground and examined, the children will see that it is gray unless held in a certain way. The blue is due to the refraction of light. The tiny parts of a feather (barbules) have structures in them that split light rays much as a prism does. The feathers of many birds will demonstrate this as most of our song birds do not have red, blue, or green pigment in their feathers.

If a bluebird's nest is located, children may be posted in a comfortable place near by, to count the number of times the little birds are fed. One child could watch ten minutes, another take his place, and so on until all have watched and recorded their observations. This can be done with little commotion if children are numbered and one child appointed to watch the time and touch the child who is to go, on the shoulder. The other children may be working in their Companion Books, reading, or carrying on any activity the teacher wishes. As each child comes in, he should put his record on the board. At the end of the observation period, a discussion should summarize the data and a group record should be made.

THE LIFE OF A SILKWORM

Pages: 242–249

Concepts:

Silkworms are the caterpillars of moths.
They hatch from tiny eggs.
They eat white mulberry leaves.
They grow very fast and shed their skins.
In about six weeks they start spinning.
Silk may be reeled from the finished cocoons.
If left alone, moths come from the cocoons in about ten days.
The moths can't fly. They mate, lay eggs, and die.

Suggested Activities:

This story was actually written by a child who raised the silkworms. Children enjoy such an activity.

Silkworm eggs with directions for their care may be obtained from the General Biological Supply House in Chicago. Once started, the teacher can save them from year to year.

To rear them, the teacher must have either white mulberry or osage orange leaves. If she has neither, she can't feed them. In the spring, the eggs hatch in about ten days after being brought out of the refrigerator. The tiny caterpillars are black and so small that it is difficult to see them. By putting a mulberry leaf on the card on which the eggs are hatching, the caterpillars may be easily transferred to their food. They will crawl onto the leaf.

At first the leaves should be cut very fine. If put into a glass dish or terrarium, they won't dry so rapidly as in a box. As fast as the leaves dry, the caterpillars need fresh leaves. While they are small, an easy way to transfer them to fresh leaves is to lay a piece of mosquito netting over the worms and leaves and then cut the fresh leaves on top of the netting. The worms will crawl up through the netting to the leaves. They may then be picked up and the old leaves thrown away.

In from three to six weeks, depending on the amount of food supplied, the worms will be ready to spin. Twigs should be supplied for them to spin on. After they have spun, remove the cocoons from the twigs. The silk from some may be unwound as described in the story. Others may be allowed to develop.

In about ten days the adult moths emerge. Put in a box together they will mate, lay eggs, and die. If the teacher wishes to keep the eggs until the next year, she should put them into a can or jar, cover, and keep them in a refrigerator or cool cellar until the next spring.

Raising silkworms is a good way to teach the cycle of a useful moth. They are clean and easily cared for; they grow rapidly and make their transformations quickly. Being domesticated, they do not wander away from food. Also it is an activity that may be integrated with social studies and industrial arts.

INSECT CATCHERS

Pages: 250–253

Concepts:

Some birds catch insects in the air.

Swallows have wide mouths with which they sweep the insects as they fly through the air.

Barn swallows build nests of mud and straw, lined with feathers. They plaster them against walls and rafters.

The female lays four speckled eggs in the nest.

The parents feed the young birds insects.

Suggested Activities:

Swallows differ from the other birds studied in the way they get their food and feed their young. If children can't watch barn swallows they may be able to observe purple martins, cliff swallows, bank swallows, tree swallows, violet-green swallows.

Swallows have been called by someone "the ceiling cleaners in the house of nature." With their wide mouths that open far back, they sweep the air for insects. The children should watch them swoop through the air and compare them with other insect-eating birds they have studied.

If a lake or pond is near, swallows may be observed flying over the water, swooping down to catch mosquitoes and other insects that swarm near the water.

Swallows have an interesting way to feed their young after they have left the nest. The young will line up on a wire or roof ledge and the parents will come darting past them, dropping insects into the open mouths without stopping.

SPRING WILD FLOWERS

Pages: 254–257

Concepts:

Wild flowers should be protected.

Pick only those that grow in large numbers.

Pick only a few of each kind.

Pick them carefully so as not to harm the plants.

Suggested Activities:

The purpose of this story should be to instill in children a desire to protect wild flowers. The teacher should learn the common

wild flowers in the region and know which ones are rare and should not be picked.

There are many interesting activities that may be carried out with this unit: going to places where wild flowers grow and seeing the type of habitat that produces different kinds; finding flowers that were used by the Indians for medicine; finding flowers that have interesting shapes like the touch-me-nots or the milkweeds.

If the children find a clump of rare flowers like lady-slippers, they may put a little fence around it and label it in some way to protect it. They may make wild flower trails with labels telling a bit about the flowers and asking others not to pick them.

Since children enjoy picking wild flowers, the teacher should try to find a place where some common ones bloom in large enough quantities to permit careful picking. California poppies, wallflowers, Bouncing Bet, Queen Anne's lace, violets, and many other common wild flowers make pretty bouquets if picked properly and arranged artistically. Stress the idea that a few flowers cared for and arranged well are more decorative than masses.

THE RED-WINGED BLACKBIRD

Pages: 258–261

Concepts:

Some birds build their nests close to water.
Red-winged blackbirds often make their nests in cat-tails.
They use the cat-tail leaves with which to weave their nests around the stalks.
Female red-winged blackbirds look like large sparrows.
The fledglings are helpless and naked at first.
When their feathers grow, the young birds look like their mothers.
Red-winged blackbirds build their nests close together.
They eat many insects.

Suggested Activities:

In WINTER COMES AND GOES the children became acquainted with one member of the blackbird family, the Baltimore oriole. He might be called the aristocrat of the family.

This story introduces the sweet singer of the swamps, the red-winged blackbird.

Within the blackbird family there is wide variety of habits, but looking closely at the birds you can see the similarity of beaks and head structure. Also listen to their alarm call. It is a *chuck-chuck*.

Red-wings build often in cat-tail swamps. The children read about the nests in the early part of the book. If they watch as the red-wings assemble in flocks and begin their courting operations, they will enjoy this story that completes the cycle.

There are few places in the United States where a variety or sub-species of red-wings are not seen during one season of the year. Their beautiful song has an organ-note quality which carries across a lake in an early morning or evening chorus. Through the day they feed on the insects in near-by fields, orchards, and gardens.

They are good parents, the dull-colored female seldom leaving the nest during incubation, the male defending it at the first alarm call from his mate.

In the South, where large flocks of the birds gather in winter, farmers complain that they are a pest in the grainfields. Studies of the contents of the birds' stomachs have proved that while a large percentage of their food is seeds, most of the seeds are weed seeds.

If the school is near any kind of pond or lake, take the children on a trip to watch for red-wings. Where there are no cat-tails, the birds will nest in low trees or shrubs, even in rosebushes in yards near a lake. They then use dried grass with which to construct their nests. By sitting quietly near the nesting site, a group of children may see the feeding of the young birds. No normal child can observe birds long without wanting to protect them.

THE SEASHORE

Pages: 262–264

Concepts:

An ocean beach has many interesting animals on it.

Part of the day these animals are covered with water. This is when the tide is in.

When the tide goes out, the rocks and animals that live near or on the rocks are uncovered.

Starfish are animals that live in the ocean.

Clams and crabs also live in the ocean.

Sea water is salty and most of the animals that live in it cannot live in fresh water.

Suggested Activities:

Children who live near the ocean will be familiar with the tide and the animals of this story, but they may have questions which the story will help answer.

The cause of tides is too complicated for third-grade children to understand but if they ask for an explanation the teacher may tell them that the moon causes them. The children know that the earth pulls things to it. All other heavenly bodies also have a pull. It is called gravitational pull. The earth's pull is gravity. The earth holds the moon in its orbit by this pull but the moon is also pulling the earth. Since the earth is much larger than the moon, its gravitation outpulls the moon's gravitation. But the liquid part of the earth, the water in the oceans, is affected enough to cause the tides.

Children near enough to the seashore should take a trip to the beach or to an aquarium to observe starfish, clams, crabs, or any other animals they can find. In an aquarium they may see a starfish climbing up the glass side or feeding on clams.

Starfish are simple animals, below clams and crabs in the order of animal life. A starfish has no division of its body into segments, that is, no head, thorax, and abdomen. Its body is radially symmetrical with the mouth and stomach in the center of the underside. The stomach is situated above the mouth, anchored by muscular bands to the walls of the five rays. The whole stomach protrudes and engulfs the food, when the starfish eats. In the ocean, starfish eat many oysters, prying the shells open by attaching a section of the tube feet to the outside of the shell and pulling. When one set of suction disks—tube feet—grow tired, there are always other rested sets to continue the pulling. At last the oyster's muscles relax, the shell opens, and the mouth and stomach of the starfish surround the soft part of the oyster.

Oyster fishermen used to gather the starfish, cut them in two, and throw the pieces into the sea. Then they discovered that each piece might grow new rays and become new starfish. Now the men put the starfish far up on the shore where they will dry out and die.

Crabs belong to the same class of animals that crayfish do—*Crustacea*—but crabs do not live in fresh water. The head and thorax of a crab are rounded, broad, and flat. The abdomen and tail are small and turned under the thorax. So crabs walk instead of swimming as crayfish do. Lobsters and shrimp are salt-water crustaceans that look more like crayfish. They eat all kinds of dead and decaying organic material they find in the water.

Clams are similar to oysters and belong to the same group of animals as snails—mollusks. Clams have soft bodies which form hard shells or exoskeletons. As the animal grows, the shell adds layers that make ridges or growth lines. The fresh-water clams or mussels have a fleshy organ called the foot, which is projected into the sand to move the clam. Their food is microscopic plants and animals that flow into their mouths with the water.

There are many varieties of all of these animals found on different coasts, and the hard parts of their bodies are often washed up onto the shore when the animals die. Children living inland should look at these shells and exoskeletons and discuss how the animals lived and were protected. They should compare them with the local members of the same group. Children often have shell collections and want to know more about them. *The Shell Book* by Rogers is a good source of pictures and information. The teacher may help the child find pictures like his shells and read as much as is needed to answer his questions.

As in all elementary science teaching, we go only so far in identification as the child's interest leads. Our main objective is always the development of the child. All the activities suggested in this lesson should help develop scientific attitudes and skills of problem solving as well as contribute concepts to an understanding of biological principles.

Teachers near the coast may wish to set up a salt-water aquarium. If so, they may write to Turtox, General Biological Supply House, Chicago, Ill., for their teachers' leaflet on salt-water aquaria.

GETTING WOOL FROM SHEEP

Pages: 265–268

Concepts:

Sheep are sheared in the spring.
We use the wool for clothing.
The wool from one sheep is called a fleece.
The sheep look thin after they are sheared.
They are dipped and branded after being sheared.

Suggested Activities:

This is a combination science and health story telling how one fabric that the children have studied is obtained.

If some raw wool can be obtained, the children can see how much oil is in it. They can wash the wool and see how much softer it becomes. They can look at the fibers under a lens and see how it differs from silk or cotton fibers. The teacher may do as much with this as she wishes, or integrate it with industrial arts.

The idea that the sheep are not harmed by being used in this way should be stressed. This might be brought out by the teacher asking such questions as, "Why do the sheepmen shear the sheep in the spring instead of in autumn? How does dipping the sheep help them? After they are sheared, dipped, and branded, how are the sheep cared for?"

If located near a sheep ranch, the teacher may take the children to visit the ranch at shearing time. Men are often glad to cooperate and demonstrate for the children. Trips of this kind need to be planned carefully and discussed beforehand with the rancher and the children. The children should have a few things they want to find out and the rancher should know them. Trips are hard work for the teacher but the outcomes are worth the extra effort.

JACK'S BATH

Page: 269

Suggested Activities:

This health lesson is for the purpose of stressing cleanliness and to show through the pictures that even in a modern age not every-

one has running water. However, that need not be too great a handicap and does not mean that one can't be clean. With many of the nation's families living in trailers, auto camps, and summer cabins, the problem of bathing may be a real one to many boys and girls. The teacher can stimulate a desire for cleanliness under these circumstances by romancing a bit. Let the children imagine that they are on a ranch, as Jack is, or in a mountain cabin, or on a tropical island where there is no running water. If the teacher can make it seem like an adventure to haul water or melt snow for a bath, she just *may* help some mother teach cleanliness.

A FRIEND OF THE FARMER

Pages: 270–273

Concepts:

Another bird that helps the farmer is the meadow lark.

Meadow larks make their nests in the grass of fields and meadows.

The nests are well hidden in the grass.

Meadow larks belong to the blackbird family.

Members of the blackbird family have the same shaped heads and beaks.

Meadow larks eat many insects.

Suggested Activities:

Meadow larks are common in all parts of the United States. They are identified in flight by their white tail feathers. Almost everyone living near the country is familiar with their song. The teacher should make every effort to have the children see and hear these birds.

People who first saw these birds in the United States probably saw a resemblance to the larks of Europe and called them meadow larks. Actually the only true larks in this country are the horned larks.

The two birds illustrate how mistakes can be made because of superficial characteristics. The characteristics which mark a family are those of structure, not color of feathers, skin, or scales. All members of a bird family have the same shaped skull, beak, and

general body shape. Their feet are alike and their wing and tail feathers similar. In many of the song birds the quality of their songs will be similar though the actual notes will be different and the song pattern vary. Learning a few family characteristics gives a child a tool by which he can identify much more easily the birds he sees. Children enjoy being able to see a bird and say, "I know it belonged to the ________________ family because it had a ________________ beak." Identification becomes not an end in itself but a means of satisfying the child's curiosity.

Meadow larks of some kind are found all over the United States and are easily seen. Their habit of singing from fence posts makes it possible to lead a group of children very close if the teacher knows how. See the suggestions for field trips in the front of this Manual.

Other common members of the blackbird family are the cowbird (the social parasite), the bobolink (who changes his coat in winter), and the bronze grackle (like the noisy club joiner congregating on street corners). Within this family, which is confined to the New World, the nesting habits run the gamut from the cowbird which lays its eggs in other birds' nests to the oriole that makes an elaborately woven nest. Since space in a science textbook doesn't permit including many individual birds, types are given to illustrate the family. The teacher should use local birds to motivate problems. These may be answered in part by observation, and clinched by reading.

A SPRING SHOWER

Pages: 274–278

Concepts:

Lightning is a big spark of electricity.
It is a kind of electricity that is in the air.
Sunlight has colors in it.
A prism will separate the sunlight into the rainbow colors.
The rainbow colors are violet, indigo, blue, green, yellow, orange, and red.

Suggested Activities:

This story is intended to answer very simply two questions chil-

dren often ask—"What makes lightning?" and "What makes a rainbow?"

Lightning is a discharge of static electricity. While third-graders can't understand lightning, they can begin to get concepts which will explain it on their level. Let them rub pieces of paper against the blackboard or any other smooth surface; then pull them away and hear the slight crackle; or comb their hair on a clear, cold day and make it stand on end; or brush a cat's or long-haired dog's hair briskly but lightly.

Experiments with static electricity are most successful on a cool, dry day. Moisture in the air conducts it away and dissipates it before enough can be collected to demonstrate the principle.

If children are afraid of lightning, tell them that when they see the lightning the danger is past; that they should stay indoors during an electrical storm, not stand by an open window or door or in a draft between two open windows or doors; also, that if they are caught in a storm to try to get into a house or building, and not stand under a tall tree. It is safer to be under the smaller trees in a grove because the tall ones are the ones most likely to be struck. Lightning causes more accidents in some regious than in others. Where lightning is a hazard, children need these precautions more than in the places where lightning strikes rarely. Knowledge of what to do in dangerous situations tends to allay fears.

Thunder is the noise caused by the sudden expansion of the air heated by the lightning and is of course absolutely harmless. It might be compared to the noise made by "popping" a bagful of air. Let the children clap their hands and see how a noise is made.

Rainbows are made when sunlight shines on drops of water in the air. The light is split into its different wave lengths and reflected back to our eyes as a rainbow. The same thing happens to light when it passes through any transparent medium shaped like a prism. The corner of a straight-sided aquarium full of water, the bevelled edge of a mirror or drinking glass, crystals of quartz or ice, and cut diamonds all have a similar effect on light. It is not necessary that the children understand the physics of it—just that they are able to interpret a common experience about which they are curious.

If the children are allowed to experiment with prisms, they will discover that they have to turn the prism just right to get the spectrum. If one prism is making a spectrum and another prism is held in the beam after it passes through the first prism, white light will come out of the second prism. This will help with the concept that all the colors together make white light. The second prism, held just right, reassembles the wave lengths again.

HOW WELL DO YOU REMEMBER?

Page: 279

This is a review page. The answers are: (1) air pressure; (2) chrysalis; (3) fossil; (4) insects; (5) three years; (6) vibrations; (7) terrarium; (8) hibernating.

OFF TO CAMP

Pages: 280–285

Concepts:

In camp, boys and girls learn to care for their health.
They learn to take care of their own tents and clothes.
They learn to care for their bodies and keep them clean.
They learn to work together.

Suggested Activities:

This is a combination science and health story. The health story is to show children the importance of regular health habits. The lever is introduced naturally as a machine that helps do work. The children do not need to understand how it helps as long as they realize that they can get mechanical advantage by increasing the distance from the fulcrum to the force. They can try this out in a small way with a ruler, a stone for a fulcrum, and a book for the weight. Try moving the fulcrum and see how it affects the effort they must make to lift the book.

Since the boys in this grade are looking forward to being Cub Scouts and the girls to being Brownies or Campfire Girls, this story should be interesting to them. Before reading it, the teacher might say, "If you were going to a camp this summer, what are some of the things you would need to know? There is a story in your book

about some boys who went to a camp. One of the boys kept a record of the rules he followed while he was there. It would be fun to see if we make some of the same rules. Perhaps we can make a better list."

As the children make suggestions, put them on the board. Ask them to tell why each suggestion should be a rule. Then read the story and compare the class list with Ted's list. Then hope that the children are sufficiently impressed to follow a few of the rules. If they have suggested a good one that is omitted from the book, so much the better. It will be more likely to be put into practice. Health teaching, to function, must become a part of the child's behavior. Health and safety concepts are the only science concepts that we believe *must* be taught, whether the children show a natural interest or not. To make these concepts function, we should use every possible means to arouse an interest and desire to practice good health habits. The more actual experiences we can give the children as reasons for these habits, the more success we shall have in establishing them.

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A KEY TO THE COMPANION BOOK

Page 1—Any reasonable answers are correct. For example: some children may check "gone to a moving picture show" in number 1 if their experience on farms has been around small towns having shows.

Page 2—Column I:

Par. 2—to the seashore, in the sunshine, in bed, out in the sun, home

Par. 3—to the mountains

Par. 4—in the woods, in a cage

Par. 5—near a large lake, around the lake

Par. 6—home, a long way off, in our yard

Column II:

Soon	the first day
early	That night
this year	After that
this summer	most every day
during their summer vacations	at vacation time
early every morning	next summer
early	in the morning and evening
A month after school was out	every day
	The next day

Page 3—Column I:

1. carefully
2. all but "run"
3. when the light across from them is green
4. always
5. yes
6. green

Column II:

1. carefully
2. yes
3. stop
4. look both ways
5. no
6. if no cars are coming
7. walk

Page 4—The red line should be just under the bark of the trunk and branches.

M—on the leaves

S—roots and branches

The food of the tree is called sap.

The simple leaves are the elm, oak, poplar, and maple.

Page 5—Column I:

1. green
2. makes food for the tree
3. dies
4. changes color
5. falls off the tree

Column II:

1. roots and branches
2. keep the tree alive
3. make the buds grow

Correct Numbers:

1, 4, 2, 3.

Page 6—1. evergreen

grows all the way to the top

2. out of the trunk near each other

all around the trunk in a circle

3. each year

Page 7—1. See text

2. 10 years

2 years

2 years

5 years

3. About 11 years

About 9 years

About 18 years

About 6 years

Page 8—The answers are self-evident.

Page 9—Some of the animals mentioned in story.

Page 10—Column I:

1. five
2. goldenrod
3. trees and bushes
4. squirrels trees
5. chipmunks cheeks
6. animals
7. autumn
8. nuts yellow

Column II:

1. winter
2. trees
3. dry—dead
4. coats
5. short
6. holes
7. food
8. hibernating

9. seeds red
10. in the fields
hibernate

9. south
10. frozen

Page 11—Column I:

1. M.	8. M.
2.	9.
3. M.	10.
4. M.	11. M.
5.	12. M.
6.	13.
7. M.	14. M.

Column II:

1. X.	11. X.
2. X.	12.
3.	13. X.
4. X.	14. X.
5. X.	15.
6. X.	16. X.
7. X.	17. X.
8.	18.
9. X.	19.
10. X.	20. X.

Page 12—First picture may show woodchuck in hole, frog or toad buried, etc. Second picture: birds or butterflies flying in flock.

1. hibernate	6. migrate
2. migrate	7. migrate
3. hibernate	8. hibernate
4. hibernate	9. hibernate
5. hibernate	10. migrate

Page 13—Children may underline more than one.
Frog—in the mud, in a hole in a tree
Toad—in the soil, in the garden
Prairie dog—in the ground
Bear—in a cave
Snake—under a stone
Lizard—under a rock
Salamander—in a dead log
Earthworm—deep in the ground
Snail—under a log
Squirrel—in a hole in a tree
Chipmunk—in the ground
Wooly bear caterpillar—under dead leaves
(These are not the only places all of these animals might be found.)

Page 14—Column I:

1. ground	11. star		
2. grass	12. park		
3. autumn	13. Orion		
4. frogs	14. suet		
5. frog	15. tooth		
6. horns	16. fish		
7. Jack	17. bud		
8. grass	18. ice		
9. twenty	19. Cecropia		
10. leaf	20. January		

Column II:

1. simple	7. logs
2. leaves	8. early
3. trunk	9. water
4. sap	10. land
5. mud	11. terrarium
6. air	12. aquarium

Page 15—Horned toad—desert terrarium with sand, cactus, or other arid land plants, dish of water.

Salamander—woods, dirt, moss, dish of water, piece of bark, etc.

Page 16—Frog—goes into mud.

Snail—can close opening in shell.

Fly—hides in cracks.

Mourning Cloak butterfly—is colored like bark.

Mouse—has fur.

Salamander—goes under logs, goes under stones (either is correct).

Snake—goes under stones, goes under logs (either is correct).

Cardinal—has feathers.

Fish—has scales.

Earthworm—digs deeper into the ground.

Monarch butterfly—flies south.

Child—has warm clothes.

Toad—is colored like the ground.

Caterpillar—spins a cocoon.

Page 17—

candy—T	peanut butter—T	onion—S
bell—H	pine branch—S	perfume—S
flower—S	drum—H	fruit—T
meat—S and H	cheese—T	banana—T
pickles—T and S	bird—H	fish—S
rooster—H	ice cream—T	water—H
horn—H	cow—H	smoke—S

Page 18— I. 1. eyes
2. go to mother or teacher
3. wash out the dirt
4. above and behind you

II. 1. taste better
2. the two holes in your nose
3. keep the dirt out
4. it is warmed

III. 1. eating, drinking
2. tongue
3. does not warm the air
4. may get germs in your mouth

IV. 1. go to a doctor
2. with care, using a soft cloth
3. it is very cold
4. hurt your ears

Page 19—Column I:

1. we watched red-winged blackbirds
2. we saw a red-winged blackbird carrying an insect
3. row into the weeds
4. the male bird made so much noise
5. the birds were gone
6. birds don't use their nests after the young birds are grown
7. autumn
8. male
9. black, red

Column II:

1. stems of weeds
2. well-woven
3. a nest you can see through
4. made of mud
5. nest-hunting trip
6.
7. well woven
8. no
9. you can see through it
10. no

Page 20—1. ~~frogs~~ nests
2. ~~shadow~~ hole
3. ~~birds~~ eggs
4. ~~woven~~ laid
5. ~~five~~ two
6. ~~mud~~ thistledown
7. ~~bean~~ thistle
8. ~~wood~~ mud
9. ~~same~~ different
10. ~~nests~~ houses

Page 21—	1. woodpecker	5. robin
	2. mourning dove	6. goldfinch
	3. swallow	7. red-winged blackbird
	4. oriole	8.

Page 22—	1.	12.
	2. cubs	13. bud
	3.	14. ends
	4. water	15.
	5.	16. seeds
	6.	17.
	7. scar	18. chrysalis
	8. roots	19. female
	9.	20. migrate
	10. leaves	21.
	11.	22. flock

Page 23—	I. 1. iron	II. ice	seed	III. 1. iron
	2. rocks	nail	shell	2. rock
	3. dirt	wood	glass	
	4. potatoes	rock	tree	
	5. apples	flower		

Page 24—The second animal would make good beef.

1. Has wide back.
6. Body is solid.
7. Has thick legs.
9. Has short thick body.

Page 25—Par. 1—2. Wool keeps the sheep warm.

Par. 2—2. The thick skin helps keep it warm.

Par. 3—3. A sheep chews its cud.
A sheep's stomach has several parts.
4. A sheep has split hoofs.
A sheep has grinding teeth.

Par. 4—2. Sheep have two toes.
Sheep have split hoofs.

Par. 5—2. A sheep's hoofs are toenails.

Par. 6—2. Tame goats are used for milk.

Par. 7—2. Goats' hair is used for clothing.

Par. 8—2. They chew cuds.

3. Their stomachs have several parts.
They have no front upper teeth.

Page 26—Column I:

3.	6.
1.	7.
4.	8.
2.	9.
5.	

Column II:
The green line would go first to the section at the right; then back up to the mouth; then down to the middle section. From the middle section it would pass to the third section at the left.

Page 27—The ways they are alike:

1. X	7. cow (might also be deer)
2. X	8. sheep (some places, goats' hair)
3. X	9. X
4. deer	10. goat, cow
5. X	11. X
6. X	12. X

cheese—cow, goat
shoes—cow, deer (by some peoples)
meat—cow, sheep, deer
mittens—sheep
leather coat—cow, sheep, deer
sweater—sheep

Page 28—Horse, zebra, donkey—one
Cow, sheep, camel, deer, pig, giraffe—two
Elephant—five

Page 29—Par. 1—3. Par. 2—3. Par. 3—1. Par. 4—2.

Page 30—Baby Teeth:

1. When you were a baby, you	had no teeth.
2. Later you had twenty	baby teeth.
3. Eight teeth were	cutting teeth.
4. Four teeth were	tearing teeth.
5. Eight teeth were	grinding teeth.

Teeth of Grown-ups:

1. Most grown-ups have	28 teeth.
2. Some grown-ups have	32 teeth.

Care of Teeth:

1. Brush your teeth	up and down.
2. Use	dental floss.
3. Dental Floss keeps food	from between your teeth.
4. Go to the dentist	if your teeth hurt.
5. Teeth need milk to	make them grow.
6. Never bite things	that are hard.
7. Brushing your teeth up and down makes	your gums healthy.

Crossed Out:
1. year, air, name, work, straight
2. think, wonder, true
3. pole, make, spider, branches
4. cheek, skin, year, run, legs, hat, school

Page 31—1. gnawing (cutting)
2. tearing
3. grinding
4. gnawing and grinding
5. tearing and grinding
6. grinding
7. gnawing
8. four
9. eight
10. all *or* different

Page 32—See text.

Page 33—Bear with cubs coming out.

Page 34—1. earthworm, spider
2. shape
3. walk, sit
4. grow, need food
5. milk

snake chicken dog

Page 35—Jimmy has mumps. Others may have them.
Susan has a cold. Others may have colds.
Jane has measles. Others would not get it from Jane.

Page 36—An Experiment
1, 2, 4, 5, 7, 9, 11, 12, 13, 14, 15.

Page 37—2. Balloon blows up.
4. Balloon collapses, may go into bottle.

1. air
2. heated
3. expanded
4. hot air
5. cooled
6. contracted
7. into the bottle or down
8. expands
9. contracts

Page 38—1. someone would be sick
2. the temperature of the air
3. not feel well
4. how hot your body is
5. find out something
6. take the cap off
7. put it in a cool place
8. the doctor says you may
9. stay in bed until you are well
10. you have a fever
11. stay out of his room
12. do something nice for him

Page 39—1. expands out
2. expands fire
3. expands burst
4. contracted down

Page 40—1. Wave the paper slowly, faster, and faster. It will make a swishing sound. Also with the hand.
2. Yes. Yes. Yes.
3. (*a*) Cicada has drumlike mechanism on underside of body. Sometimes called locust (incorrectly) and dog day harvest fly.
(*b*) Cricket rubs rough edges of wings together like sand blocks.
(*c*) Grasshopper's legs are like cymbals.

Page 41—Nuthatch: suet, nuts
Sparrow: seeds, chicken feed, bread, oats (will eat other food also)
Junco: seeds, corn, oats, bread, chicken feed
Chickadee: suet, nuts
Horned Lark: seeds, oats, corn, bread, chicken feed
Quail: seeds, corn, oats, bread, chicken feed
Cardinal: sunflower seeds, apples, berries, corn, chicken feed
Downy Woodpecker: suet, nuts
Blue jay: all kinds fed to other birds
Goldfinch: seeds, bread

All drink water.
All will eat other seeds, bread, or oats if very hungry.

Page 42—Pictures from left to right:
Top row—oriole, cardinal, brown creeper, robin, brown creeper.
Bottom row—brown creeper, goldfinch, downy woodpecker, chicken, duck.

1. seeds
2. insects
3. insects
4. stiff
5. tree
6. water
7. ground

Nuthatch upside down.
Brown creeper right side up.

Page 43—1. 1st and 3rd
2. 2nd
3. 1st and 3rd
4. 2nd
5. 1st
6. 1st
7. 3rd
8. 1st and 2nd

Page 44—If possible, let children walk past a light to demonstrate.

Page 45—clock
The shell in the last part is half of a coconut shell.
The hole may be made with a small nail.

Page 46—1. crescent moon
2. full moon

1. 1st quarter
2. full
3. 3rd quarter
4. crescent

Page 47—I. sheep
duck
turkey
dog
squirrel

II. Shirt, dress, underwear, possibly socks.
(could be some argument that these might be silk, but rayon is from plants)

Page 48—Heat goes through silk most rapidly, cotton next, wool least.

Page 49—1.
2. warm
3. wool
4. hair
5. cotton
6. silk
7. protection
8. caterpillars

Page 50—*Incorrect*	*Correct*
1. bud	stem
2. cotton	geranium
3. roots	flowers
4. years	days
5. flowers	roots
6. pounded	pressed
7. geranium	narcissus
8. tulip	bean (or other seed)
9. narcissus	geranium
10. tall	strong

Page 51—1. Rose slip. 2. Roots on slip. 3. Planted. 4. Plant growing. 5. Rosebush with buds.

Page 52—1. hibernate
2. true
3. garter snake
4. true
5. flies, grasshoppers, butterflies
6. goldfinch, red-winged blackbird
7. true
8. milk
9. goats
10. kids
11. true
12. true
13. rest
14. hibernate
15. north
16. true
17. pointed
18. air
19. true
20. true
21. goldfinch
22. robins
23. true
24. cold

Page 53—1. he wanted a dog
2. they are so easily trained
3. there was no present at his plate
4. I want the children to see him
5. he will not take care of himself
6. Dick has two dogs
7. I like Copper
8. his nose is cold and wet
9. to hold her food
10. its claws do not touch the floor
11. they hunt at night

12. dogs use their noses more than their eyes
13. bones will keep its teeth clean

how—She licks her paws. She licks her hair.
what—1. sweet milk
2. cooked fish and meat
3. birds
4. three kittens
5. their own food
6. birds

Page 54—Any statements that are correct.
Last group:

1. sweet	3. curd
2. sour	4. solid

Page 55—Scotch child with West Highland cow
Swiss child with goat
Indian child with water buffalo
Himalayan child with yak
Eskimo child with reindeer

Series showing straining of milk, churning.

Page 56—Any of the foods which would make a balanced meal.

Page 57—Hunger Moon: January or February

Ice Moon:	December
Moon of the Flowers:	May, June
Leaf-Falling Moon:	September, October

(It would depend on the locality)

Page 58—Fossils at bottom of page are:
trilobite torachiopod crinoid coral snail fern
Modern relatives:
crayfish barnacles starfish coral snail fern

Page 59—1st sentence, picture 6.
2nd sentence, picture 1.
3rd sentence, picture 4.
4th sentence, picture 2.
5th sentence, picture 5.
6th sentence, picture 3.

Page 60—The softer and more vividly colored the rock is, the better the "paint."

Page 61—1. north
2. west
3. east
4. north
5. west
north
east
6. south

Page 62—Expression of concepts through drawing.

Page 63—1. beating
2. rolling
3. cutting
4. dissolves, goes through
5. freezes, breaks
6. carry away
7. heats
8. expands
9. blows sand
10. wears the rock away
11. blows the water
12. breaks, hits
13. carry seeds to the cracks
14. grow in the cracks
15. roots grow into the rock

Pictures show different agencies. Children may underline more than one word.

Page 64—Animals in first group of pictures—these may be very small.

ant beetle worm grub milliped spider

The idea is not to identify species but types.

Second group of pictures—

sand grains roots mites or other tiny spiders caterpillars beetles

In the experiment the top layer will be finest; the bottom, coarsest.

Page 65—Children may show rain and small streams in top picture. Show soil in the air in bottom picture.

Page 66—1. fossil
2. limestone
3. acid
4. shale
5. sandstone
6. quartz
7. clay
8. humus
9. minerals
10. earthworm

Page 67—Pictures:

1. half a coconut
2. coffee can
3. peanuts on string
4. dry bread
5. dry doughnut
6. apple cores
7. cranberries
8. bone

For ground-feeding birds, put these on a shelf or ground. Even ground feeders may try to get them from strings, however. A small block of wood with a nail through it may be hung from the string with the doughnut, and the doughnut put over the nail.

1. The ones containing suet, fat meat, nuts, doughnut.
2. Bread, inside of doughnut, seeds.

Page 68—Picture 3 may show male bird singing, one being driven away, or male courting female.

If children color the pictures, be sure they show difference in male and female.

Last picture should show nest returned to a bush.

Page 68—Flower pot hole is large enough for a chickadee or nuthatch. Wrens might use it.

The hole in the gourd is large enough for a bluebird. Tree or violet-green swallows might use it. Wrens will go into any house at times.

The open house may be used by robins, or other birds that nest in tree crotches.

Page 70—Children might draw a tin collar for the first tree, or tell about it.

Second picture shows a forest fire. They could show someone putting out a camp fire, or anything that would prevent such a fire.

Third picture: winter, ice, frozen pond. Put out water and food for the birds.

Page 71—Chinese girl lives in China.

The series of pictures the children make may be similar to those in the book, or of their own activities. Should be simple.

Page 72—1. eggs
2. feeding caterpillars
3. mulberry leaves
4. box
5. sick silkworms
6. silkworms shedding skin
7. cocoon
8. spinning
9. silk cocoon

Page 73—Pictures:

penguin	U	diving bird
swan	O	swims
tree swallow	T	catches insects in air
tern	T	darts down to water like a dive bomber
hawk	F	floats
goose	O	swims
eagle	F	floats
barn swallow	T	catches insects in air

Page 74—3, 9, 1, 4, 6, 8, 5, 7, 10, 13, 11, 12

Page 75—trillium, lily (Both have parts in threes.)
hepatica, anemone (Leaves are cut like a crow's foot. Blossoms with five petals.)
violet, pansy (Five petals, honey spur.)
bloodroot, poppy (Four petals, deep-cut leaves.)

Page 76—

Garden flowers	*Wild relative*
geranium	wild geranium
cornflower	dandelion
calla lily	Jack-in-the-Pulpit
tulip	trillium

Page 77—*Blackbird family*:
Meadow lark
Yellow-headed blackbird
Grackle
Oriole

Finch family:
Song sparrow
Goldfinch
Junco

Swallow family:
Tree swallow
Cliff swallow
Barn swallow
Bank swallow

Page 78—1. chickadee
woodpecker
2. quail
sparrow
3. cats
4. dozen
5. mulberry leaves
6. little holes
7. cardinal
8. watch it
9. easily seen
10. eating insects and seeds
11. humus
12. alive

Page 79—Deep water:
- Fish
- Coral, attached to rocks
- Lobster

Shore:
- Conch shell

Above water:
- Gull

Shallow water:
- Crab
- Clam
- Oyster, attached to rocks
- Starfish near oyster

Page 80—1. Number 3 is best. Number 2 is correct also.
2. Number 3 is best.
3. Number 3 is best. Number 1 is correct also.
4. Number 3 is best. Number 2 is correct also.

Scientific attitudes test.

Page 81—Page 80 continued.
5. Number 4 is best. Numbers 2 and 3 are correct also.
6. Number 4 is best. Number two is correct also.

Page 82—Cat: basket with leash or cage.
Dog: basket with leash.
Fish: aquarium.
Hen: cage.
Horse: bridle, halter, post or tree outside in shade.
Turtle: terrarium.
Rabbit: cage.
Lamb: pen outside.

Page 83—Right way:
- Rabbit in both hands, *not* by ears.
- Chicken with hand under it.
- Cat washes herself.
- Dog should be brushed.
- Goldfish handled with net.
- Turtle in terrarium.

Page 84—Second one will burn.
Drinking from first glass.
Second can will pour.
Second tube will work.

Page 85—The answers are self-evident.

Page 86—Cattle: glue, soap, lard, cheese, hairpins, buttons, knife handle, shoe.

Sheep: yarn, skin coat, lamb chop, blanket, candle.

Pig: bacon, brush, ham.

Page 87—

1. X	5. X	9. X	13. X
2.	6. X	10. P	14. P
3. X	7.	11.	15. X
4.	8. P	12. X	16. P

Page 88—

1.	6. X	11.
2. X	7. X	12. X
3. X	8.	13.
4.	9. X	14. X
5.	10. X	

Page 89—Robin, goldfinch, cardinal, blue jay, downy woodpecker.

Junco, oriole, bluebird, horned lark, song sparrow.

English sparrow, meadow lark, red-winged blackbird, barn swallow, nuthatch.

Page 90—Flowers from left to right:

Violet	V
Cornflower	I
Hepatica	B
Jack-in-the-Pulpit	G
Daffodils	Y
Nasturtium	O
Paintbrush	R

Birds from top to bottom:

Violet-green swallow	V
Indigo bunting	I
Bluebird	B
Parokeets	G
Goldfinch	Y
Oriole	O
Cardinal	R

Page 91—

1. sting	2. six legs
six legs	four wings
hibernate	
four wings	

food

Pa k

e-Pulpit

Pa

Pa

itten

y caterpillar

adpole

Pa

ours

Pa

1. sand
2. loam
3. fledglings
4. silkworms

1. starfish
2. tube feet
3. crab
4. shears

3. insects | food
hairs on bodies | six legs
can sting

Page 92—1. salamander
2. bumblebee or wasp
3. earthworm
4. garter snake
5. snail
6. woodchuck
7. goldfinch
8. goat
9. fish
10. Jack-in-the-Pulpit

Page 93—1. (2)
2. (1)
3. (2)
4. (2)
5. (2)
6. (2)
7. (2)
8. (1)
9. (2)
10. (1)

Page 94—Right side of page:
4. kid 1. calf 9. kitten
3. lamb 10. butterfly caterpillar
5. silkworm moth caterpillar 7. puppy
2. fawn 6. fledgling 8. tadpole

Page 95—1. cubs
2. migrating
3. flock of
4. terrarium
5. aquarium
6. insect
7. hibernated
8. parents
9. kids
10. fawns
11. timber line
12. trail
13. female bears
14. quarantine
15. expands
16. contracted
17. molt
18. twenty-four hours
19. cream
20. fossils

Page 96—1. soil
2. beef
3. minerals
4. humus

1. hepatica
2. cat-tails
3. marsh
4. tide

1. sand
2. loam
3. fledglings
4. silkworms

1. starfish
2. tube feet
3. crab
4. shears

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